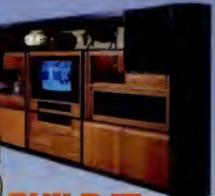


JUNE 1986 \$1.50

Popular Mechanics

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Center



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YOURSELF

TOMORROW'S TRUCKS

18-Wheelers Will
Be Bigger, Faster,
More Efficient

8-CAR MINI-GT SHOOTOUT

Practicality
Plus Punch
In A Small
Package



NEW WAVE IN CLASSIC BOATS

Replicas That Roll
A Golden

06
GTS
GEAR
Ouch

SPACE 1999
How We'll Live
In Orbit





Ford

Welcome to the Age of Aerostar.

Ford announces a new mini-van with the biggest payload* and the highest gas mileage rating in its class!**

Once again, Ford moves ahead in van design. Introducing Aerostar—a new concept in business efficiency.

Most aerodynamic van.

Aerostar's advantages start with its sleek, wind-splitting design. Low drag coefficient of .37 makes it the most aerodynamic van in America. And the resulting good looks are good for any business.

High-MPG Four or husky V-6 power.

For maximum mileage, choose Aerostar's advanced Four with multiport electronic fuel injection. Its EPA estimates of 26 city MPG, 29 highway MPG are the best of any mini-van.*

For extra power and response, choose the optional 2.8L V-6. The V-6 is bigger and stronger. But like the Four, it's a modern computer-controlled engine.

Biggest payload.

The truck-tough Aerostar can shoulder over a ton* of payload—the most of any



mini-van. There's plenty of space to put the load in, too. Cargo floor behind the seats is over 7 ft. long.

Flat, low-lift floor.

The rear liftgate swings up out of the way, so you can step right up to the level cargo floor for easy loading. Ground-to-floor lift is only 25.8 in.

Tows 2½ tons.

Here's another measure of this Ford's capability. Because of its high strength, rear-wheel drive and optional V-6 power, Aerostar can be equipped to tow 5,000 lbs.

That's 2½ times more than front-drive vans!†

Whether you're towing or hauling, the added weight is on the rear driving wheels where it needs to be for full traction.



Longest wheelbase, shortest outside length.

Aerostar's 119-in. wheelbase is the longest of any mini-van for a smooth ride. But it's the shortest van overall and very maneuverable. Turning diameter is 3½ ft. smaller than the Dodge Mini Ram van.

Easy to get into, to handle, to drive.

Aerostar makes everything you do easy to do. Doors are high, wide, easy to open. The step to the driver's seat is low, but you sit tall with a commanding view of the road ahead. Steering, manual or power, is quick rack-and-pinion.

Garage it anywhere.

The maneuverable Aerostar parks with minimum space and effort. It's sized to go in virtually any standard garage or through the car wash.

Built Ford Tough.

Ford took the time to make Aerostar right the first time. Built to pass the same durability standards as big Econoline vans, it's already had over a million miles of accelerated testing. Now it's ready for you.

Lifetime Service Guarantee.

Participating Ford Dealers stand behind their work, in writing, with a free Lifetime Service Guarantee for as long as you own your Ford car or light truck. Ask to see this guarantee when you visit your participating Ford Dealer.

Buckle up—
together we can save lives.

How the Mini-vans Compare

	FORD AEROSTAR	DODGE MINI-RAM VAN
Aerodynamic for lower air drag	.37	.42
Standard 4-cyl. engine	2.3L	2.2L
Electronic fuel injection	YES	NO
V-6 engine option	YES	NO
Maximum towing†	5000 lbs.	2000 lbs.
Maximum cargo volume cu. ft.††	140.3	133.0
Longer wheelbase, smooth ride	119 in.	112 in.
Short turning diameter	37.5 ft.	41.0 ft.

*With optional payload package. **EPA estimates 26 city MPG, 29 highway MPG equipped with 2.3L Four EPI and standard 5-speed manual transmission. †Reduced by passenger and cargo wt. in towing vehicle. ††Based on SAE-J-1100 Code V-6.

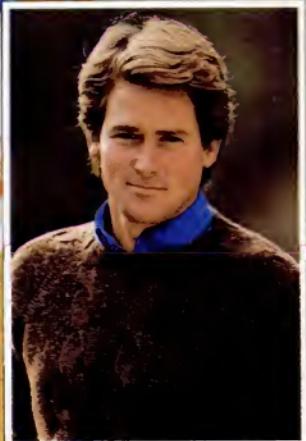


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The Wide Stick.[™]**

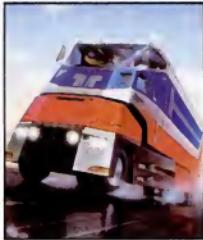
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to evaporate.
Its protection
lasts 24 hours.
That's 110%
protection.
That's your edge.*



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JUNE 1986

VOLUME 163 NO. 6



ON THE COVER

The futuristic semi-truck, conceived by Richard Thomas of Oklahoma State University, is just one design for long-haul trucks of the future. The new rigs will do more than just save fuel. They'll deliver better handling and visibility, more room and less noise. Read about what's on the drawing boards—and what's already on the road—in the story that begins on page 65.

PM drawing by Larry Dodge
Skidmore/Saharani Studios



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74 Classic boats



92 Sound construction



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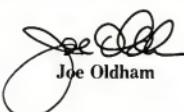


Next month is a very special one for us—and we hope for you. In commemoration of the 100th anniversary and rededication of the Statue of Liberty, we're publishing a special double issue of POPULAR MECHANICS. The July issue will contain all the regular columns and features you expect in every issue of POPULAR MECHANICS. But you'll also find in the July issue what amounts to a second magazine, called *The Building Of America: Where We've Been, Where We're Going*. We've asked the very best authors in America to take a look at our country's past, present and future, and give you their unique visions and extraordinary insights. And when I say the best authors, I mean literary superstars like James A. Michener, Tom Wolfe, John Naisbitt, Isaac Asimov, William F. Buckley Jr., Richard Reeves, William Hoffer, Eric Sevareid, Betty Friedan, Jeff Greenfield and more. We've even lined up Bob Hope to give you his own inimitable view of Miss Liberty, and we'll have a special message from President Reagan. I can't think of any instance where so many distinguished writers have been between the covers of the same magazine at the same time. The July issue of POPULAR MECHANICS will truly be a literary event that you won't want to miss. I hope you'll look for it and enjoy it for many years to come. . . . In 20 years as an editor, mostly in the automotive field, I've been involved in many project cars. All of them have been frustrating experiences at best. But the T-Bird in this issue (page 78) was one of the least frustrating. In fact, it came out pretty good, thanks to Bill Kolb and his organization. Basically, a project car is an undertaking by auto editors who think they're smarter than factory engineers and who think they can improve a car by adding, subtracting and modifying various components. Bill Kolb, a born-again hot-rodder from way back and the owner of Faulkner Ford and Spoilers Plus in Blauvelt, New York, helped keep us on track during our project, and his shops did much of the physical labor for us. That's why this project car was less frustrating than most. Kolb bore most of the frustration. In the end, we wound up with a Ford Thunderbird that has much of the style, performance and the panache of a Euro-style AMG-modified Mercedes-Benz 560SEC. If you saw our car displayed at the New York Automobile Show or



Kolb with one of his hot Thunderbirds.

any of the other shows it has been at, you know it's a very cool piece. . . . There's nothing quite like Lake George. To me, Lake George, in the upper Adirondack region of New York state, is the most beautiful lake in North America, and I've seen a few of them. That's why I envied Boating/Outdoors Editor Tim Cole so much when he went off to Lake George to photograph the boats for our *Splash From The Past* article on page 74. The mansions along the Lake George shoreline surely evoke images of a golden age past, as do the replicas of classic boats that are so popular these days. Tim assures me, however, that the lake itself is still beautiful and still an original, a classic that can't be replicated. 'Til next time.


Joe Oldham

Popular Mechanics

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Athabasca Falls. A rugged place for a smooth whisky to start.



ALBERTA, CANADA—Out here, nature's the boss. And you don't ever forget it.

I guess I expected sort of a picture-postcard waterfall. This one roars by like a freight train.

The water is so cold it almost hurts to drink.

It's water like this, from the glacier fields, that helps make Windsor Canada's smoothest whisky.

They also use rye grown in the rich, black earth around Calgary. And the air helps, too. Windsor is aged in the cleanest, crisp-est air I ever breathed.

Out here, nature's the boss. And Windsor is Canada's smoothest whisky because nature makes it that way.



WINDSOR
CANADA'S SMOOTHEST WHISKY.

NOW YOU CAN CONQUER RUST!



New NEUTRA RUST Gets Rid of Rust For Good!

NOT A PAINT, NOT A COVER-UP, but an entirely new and revolutionary process for eliminating rust. Neutra Rust was originally developed to control the incredible rust on oil rigs in the North Sea and on ships of the Royal Navy. Think of the rust problems they have! Naturally they use vast quantities of Neutra Rust and buy it in huge 50 gallon drums. For a long time that was the only way you could buy it. But at last Neutra Rust is available in smaller sizes for home and shop.

Now you can get rid of rust for good just the way they do at industrial and military installations all over the world!

WHAT NEUTRA RUST DOES

Neutra Rust is like nothing you've ever used

before. It's amazing! No tiresome scraping, wire brushing and sanding to get down to bare metal. Neutra Rust works best applied right over rust! It penetrates the rust. Gets right down there and chemically changes the rust into an entirely new substance—a hard, black, paintable compound called ferroferric. The rust is gone—not just covered up—GONE! For good. It no longer even exists.

NEUTRA RUST IS EASY TO USE

First knock off the loose or scaly rust, but leave the rest of the rust there. (Remember Neutra Rust works with rust!) Then just brush Neutra Rust on. Within minutes that rust will be gone and the new surface will be there. That's all there is to it. Clean up is easy, too. Just soap and water.

YOU CAN ACTUALLY SEE NEUTRA RUST WORK!



When you first brush on Neutra Rust it is white. Then, as you watch, it turns pale green, then darker green, then finally a deep, wrought-iron

black. What you have seen is the rust being chemically converted. The hard new surface can be painted any color you want, or left as is.

USE NEUTRA RUST ON: Automobiles • Boats
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POPULAR MECHANICS • JUNE 1986

Letters



Barnstorming



Raise you one: Sysmsa's 3-door was built from PM's 2-door plans.

For years, I've wanted to build a garage workshop. I'm glad I saw your plans in the Sept. '84 issue. (*Build Our 'Country Barn' Garage*, page 90).

I have only slightly modified the plans to suit my own needs. The changes were: three bays instead of two, back one-third walkway enclosed, ceiling 10 ft. instead of 8 ft. Also, I let the roof rafters run the whole length: 16 ft. in the front and 22 ft. in the rear.

For siding, I used locally grown cedar boards and batents cut by my neighbor. The building is now complete and insulated and I'm really pleased with the results. My complements to Richard F.



Reader Schleimer modified his barn for more garage space.

Dempewolff for the plans.
LOUIS SYTSMA
PORT PERRY, ONTARIO

I built the garage barn from your plans and am very pleased with it. What I did, though, is modify the design to allow you to walk up the stairs without stooping and get you more space in the garage area. Two-thirds of the overhang were enclosed and set back 6 in. to keep the same look as the original. I cut a door in the siding under the stairs and use the space for storing garden tools. Keep those great articles coming!

NORMAN SCHLEIMER
ARMONK, NY

There's more than one way to raise a barn, but you can start with PM's plans. The drawings, instruction manual and materials list are \$30. A second set, if you need it for any reason, is \$20 when ordered with the first set of plans. Send check or money order to Colonial Garage/Barn POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101. Allow four weeks for delivery.

Upscale Inflatable

Your article on using a motorized inner tube as a tow for snorkeling (*Build PM's Snorkel-Tow For Lazy Summer Fun*, page 68, Aug. '84) was a great idea. When constructed on a larger scale it becomes a terrific miniboat! Our deck is a 4-ft.-dia., $\frac{3}{8}$ -in. plywood board painted with epoxy for durability and water resistance.

Weight nylon straps secure it to a 5-ft.-dia. farm tractor inner tube. A 15-pound thrust electric trolling motor is mounted through the deck. A safety flag and small airhorn are a must. It's great on our favorite lake.

DANIEL BEACH
OAK PARK, IL

When you're really ready to move up and go yachting, see what the inflatable pros like Achilles, Avon, Boston Whaler and Sea Eagle have to offer!



Dames at sea: Crafty variation of PM's Snorkel-Tow floats two.

Not poles apart

Maybe it is a great surprise that an unknown person from Poland write to you. I would like to correspond in Polish or English with computer enthusiasts, modelers and stamp collectors. I'll be very glad if you help me find pen-friends in other countries, too. My hobbies: R/C models of helicopters, airplanes and cars, and some photography. I also wish to swap LP records, books, modeling and computing magazines in English, French and German. I am 30 years old and will reply to everybody who writes to me. Thank you for help.

MARIAN NAZIMEK
RYNEK 14
46-250 WOLCZYN, POLAND

Good balance

In *Pontiac's Balancing Act (Inside Detroit*, page 28, March '86), Jim Dunne says the modern use of balance shafts in automobile engines "was begun five years ago by Mitsubishi." But before that, Ford designed a V4 engine with a balance shaft for the Cardinal. This car was never built here, but Ford sent the blueprints to England and Germany, where the engine was built. Ford sold the engine to Saab, which used it in the model 95 and 96 from '67 until '74.

As a Saab owner and ex-Saab mechanic, I've worked on a lot of these engines, still drive a car with one and consider them excellent. When the Mercury Capri first came out with its V6, it was this engine with two cylinders added but without the balance shaft.

Fritz Guenther
Auto Mechanics
Instructor
Western Nebraska
Technical College

Still drillin'

I thought you might be interested in how well your projects hold up. The picture shows a drill press I made from your blueprint No. SN895 (which I still have) shortly after my wife and I were married 50 years ago. I'm still using it in my workshop. The bearings are from a model T Ford and the rear pulleys are made of wood.

ED ALTBENBACH
OAKLAND, CA

The Homemade Ball-Bearing Drill Press first appeared in our Shop Notes section in September '34. PM



Still in use, 50-year-old drill press was built from PM plans.

In some cars, a turbo In Thunderbird, it's

It's one thing for an automobile to offer turbocharging.

It's altogether another thing for an automobile to be designed for turbocharging.

Thunderbird Turbo Coupe adheres to philosophy number two. Some points of proof:

To withstand the heat and stress generated by turbocharging, Turbo Coupe's overhead-cam 4 cylinder engine has high-temperature alloy valves, forged aluminum pistons and an externally mounted oil cooler for effective lubrication.

(The result is 155HP at 4600 RPM*)

The five gear ratios allow the driver to keep the engine within its optimal torque/power band during acceleration, cornering, and after braking.

Under adverse road conditions, the Traction-Lok limited-slip differential delivers power to the wheel with the most traction.

In turns, on rough roads or under acceleration, Turbo Coupe's unique Quadra-Shock suspension enhances stability by reducing fore-and-aft axle travel. Goodyear P225VR60/15 "Gatorbacks" (derived from Formula One rain tires) spread the power over a 7" wide tread. And the rack-and-pinion power steering provides 2.5 turns lock-to-lock.

Other items of note: articulated seats provide a high degree of lateral support during cornering, and adjust to a wide range of physiques;



charger is everything. just the beginning.



Buckle up—together we can save lives.

all instruments are analog for quick-read information; and the most visible design element of all: Thunderbird's shape. A shape which helps improve directional stability and road-holding by reducing front and rear lift.

But perhaps the most telling fact of all is this: Turbo Coupe offers no performance options. Because none is needed. The performance gear is included as part of the overall design. Proof, we feel, of a high performance automobile's basic integrity.

3-Year Unlimited Mileage Powertrain Warranty.

The new 3-year unlimited mileage warranty covers major powertrain components on 1986 Ford cars. Warranty is limited and certain deductibles apply. Ask to see the 3-year unlimited mileage warranty when you see your Ford Dealer.

Best-built American cars.

"Quality is Job 1." A 1985 survey established that Ford makes the best-built American cars. This is based on an average of problems reported by owners in a six-month period on 1981-1984 models designed and built in the U.S.

See the Turbo Coupe, available to buy or lease, at your Ford Dealer.

*Based on SAE standard J1349.

Have you driven a Ford... lately?



This One



Copyright 1986 Ford Motor Company

Imports

BY BILL HARTFORD

The toys of summer



Saab Turbo Cabriolet, with U.S.-built soft-top, is now on the road in limited numbers.

Soon, when the heat really starts beating on your brow, you'll wish you were somewhere like Finland, enjoying icy blasts from the north. Coincidentally, the Scandinavian country is also the source of a new joy of summer, Saab's convertible. Saab's factory in Finland has long made various models of the Swedish car, and now is building the new 900 Turbo Cabriolet. If you move fast you'll find one of the silver beauties at a Saab dealer right now—literally one because '86 production is only 350 cars, roughly a single car per dealer. In '87 there'll be more cars and colors.

If you doubt the ability of

snowbound Scandinavians to build a \$23,000 summertime car, note that the slick, fully lined, tough top is made by ASC in the U.S.A. It's air-freighted to Finland for installation on the hydraulically operated frame. The zip-out glass backlite with its built-in defogger can be left in place when you raise and lower the black cambria cloth top. With the top down at 100 mph, only your hair will stand on end. With the top up, the canvas could be sucked right off the frame. But ASC and the high-speed Swedes have the design worked out so you won't wind up with a rag roof.

Other new convertibles



In Tokyo, white convertibles stole the motor show. Mazda 323 (top) with roll bar is now a production model. LUC-2, an idea car from Nissan, is powered by a new dohc, 16-valve, 1.6-liter Four.

are making appearances left and right: In Japan and Europe topless is a trend. At the Tokyo Motor Show every other automaker displayed an experimental design or prototype that opens all the way or partially. (And it appeared that a blizzard had hit the show stands as the color fashion sweepstakes went to white.) Mazda's 323 Cabriolet is now in production. Nissan's LUC-2, a 2-seater with unique powered glass canopy, is an idea car whose time might come.

In Europe, now swirling around the *Arc de Triomphe*, is a convertible version of Peugeot's cute-as-a-button 205. The 205 is the most incredible success story in the history of the French motorcar, and the



Peugeot 205 is sure to be most popular convertible in France.

convertible is sure to add another chapter. Pininfarina designed the drop-top, and the 205 originated with him as well (see *Imports*, page 10, Nov. '84). The 205—and now the convertible—is a terrifically appealing little car that, unfortunately, we don't get here. So, at least for now, when it comes to an affordable (\$10,000 to \$15,000), imported, 4-seater soft-top with roll bar, the Volkswagen Cabriolet is the only game in town—and a nice one. But it's time it had some competition.

Fordable Festiva

On your next trip to Japan, be sure to stop by an Autorama dealership, where you'll



Festiva in head-to-toe white is the "Hot Exterior" model S.

see a sign, "We are the Ford," and check out the new Festiva. Why? 'Cause it's coming over here. Right now, it's one of the cars that Ford sells in Japan through its Autorama network. The Festiva is also made in Japan—by Mazda, Ford's partner there. (Ford is the only U.S. automaker to sell Japanese-made cars in Japan under its name.) Soon, the Ford Festiva will be made in South Korea—by Mazda's partner, the Kia Industrial Corp. Then it will be shipped, with Ford nameplate, to—you guess it—the U.S.

In Japan, the little Ford is available in L, L Special, S, Ghia and Canvas Top versions. The slide-back canvas sunroof is something new for

the Japanese, but familiar to us. Competition for the Festiva, which is 140.7 in long overall, comes mainly from Honda's popular City model, and from other minis like the

Toyota Starlet and Nissan March. Four-cylinder engines come in 1.1- and 1.3-liter displacements, with the sportiest setup being the S model with "Hot Exterior," as the all-white, monochrome treatment is called. This is a really early preview of the 90.4-in.-wheelbase Festiva since North American debut will not be until the middle of 1987 in Cana-



Sliding roof of the Canvas Top model resembles Renault LeCar.

da, and later in the year for the U.S. That's plenty of time to get the name straight: It's not Ford Fiesta, it's Festiva.



Small Wonder

It's here, pocket-size radar protection.

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slide into a shirt pocket, beautiful enough to win an international design award.

Small means nearly-invisible protection

That could only be PASSPORT. It has exactly what the discerning driver needs, superheterodyne performance in a package the size of a cassette tape.

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedent in radar detectors. It's no surprise that such a superlative design should be greeted by superlatives from the experts.

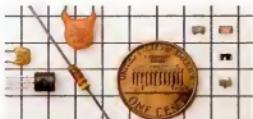
"In a word, the Passport is a winner," said *Car and Driver*.

The experts report excellent performance. Simply switch PASSPORT on and adjust the volume knob. Upon radar contact, the alert lamp glows and the variable-pulse audio

Small means the size of a cassette tape

begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of Hewlett Packard LEDs shows radar proximity.

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In PASSPORT, 102 SMDs (right) do the work of ordinary transistors, resistors and capacitors.

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Science

BY DENNIS ESKOW



Beam in our eyes

Computer miniaturization has become so familiar to us, we hardly bat an eyelash at comparisons between the ancient Eniac computer and today's desktop models. But scientists at Argonne National Laboratory recently showed us a breakthrough that promises yet another miniaturization revolution. They are trying to create a microprocessor so small you'll need a microscope to see it. Stage one involves measuring magnetism on a surface less than one atom thick. Argonne has devel-

oped a technique called Surface Magneto-Optic Kerr-Effect, or SMOKE. By firing a laser on a super-thin strip of gallium arsenide, the scientists can measure magnetism on a space a few atoms thick. The technique will eventually replace the counting of electrons passing through a circuit with the pulsing of magnetism on the tiny surface. Theoretically, once it's fully developed, one computer chip may hold as much memory and processing capability as several minicomputers.

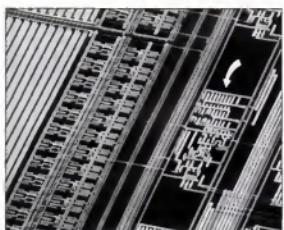


Argonne National Lab's SMOKE laser is building tiny computers.

Ghost busters

A Purdue University research team working on electronic background noise problems has come up with a computer chip device for your TV that may double the number of satellite-dish antenna users. The microchip uses new architecture to eliminate "noise" caused by weather conditions or land obstructions when a signal is beamed from point to point through the atmosphere. One of the so-called nonlinear filtering devices can perform up to 48 op-

erations per second to straighten out a wobbly signal. The chip can correct a signal obscured by trees or buildings. That means many people who could not install a satellite dish in the past may soon be able to do so.



Magnified TV chip shows filter (arrow) that will improve signal from satellite dish.

Echoing theory

Shoot a radar beam at one of Jupiter's three icy moons and the return signal will drive you crazy. The beams somehow get split. Electrical engineering Professor Von Eshleman of Stanford University thinks he's figured out why. Ice on Europa, Ganymede and Callisto may bend radar beams the way water droplets in clouds bend sunlight, Eshleman says. As the ice bends the beams, craters buried beneath the surface may then refocus them and produce the split-beam effect.

In addition, the ice on the Jovian moons probably formed in layers, which would fragment the bent beams. If Eshleman's theory holds up, the return signals from future radar probes of the outer planets will make much more sense.

Aero fun

In springtime, a young man's fancy turns to baseball. Or football. Or Frisbees. We love to throw things. A relatively new throwing "toy" is called the Aerobie. It's plastic and it looks like a Frisbee with the center cut out. The outer edge has a large, tapered spoiler rim and the inside edge has a smaller taper to its spoiler shape. The result

is perfectly balanced aerodynamics. Thus, an Aerobie has been thrown 1046 ft., compared to the record 550 ft. for a Frisbee.

These facts and other interesting tidbits are contained in a delightful new book called, appropriately, *The Aerobie Book* (Klutz Press, Palo Alto, California). It includes exciting throwing experiments.

Cancer breakdown

We are far from the light at the end of any tunnel in the war on cancer, but some big battles are being won. At Harvard Medical College, researchers Debajit K. Biswas and David T.W. Wong may have won a major battle in the oral cancer area. They've discovered the stages in which a normal cell turns on a gene, and that starts the process toward mouth cancer. Tumors start out as normal tissue, change shape at a specific site, then become precancerous and then cancerous in stages. Some years down the line, when other researchers can confirm the Harvard findings and can standardize them, doctors will be able to take cultures from a patient's mouth and predict the coming of cancer in plenty of time to deal with it. **PM**



17



18



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7

PICTURE YOURSELF

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Note in the photos around the page how the change each day seems like no change at all. But compare #1 (when he began) with #18. The nearly invisible day-to-day changes have eliminated the gray and created a younger looking man.

You can do it too. Not necessarily the way this Grecian user did. You may have more or less gray to start with. And you may want to end up with more—or less. You're in control. A lot of Grecian users leave a little gray on the sides.

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Electronics



BY STEPHEN A. BOOTH

Tickle those ICs



Technics' SX-PX1M: Real acoustic sound in an electric piano.

Imagine never having to tune your piano? You could hang up the tuning fork if your piano were electronic. Now what if it also had the sound and feel of an 88-key acoustic Steinway Grand?

That's exactly what hi-fi maker Technics has accomplished in its first line of digital, electronic pianos.

Electronic pianos have been around for some time. The best of them even sound like pianos, with all the vibrant warmth of hammer-struck strings resonating in a wood enclosure. What's tougher to achieve electronically is the dynamic percussion of an acoustic piano.

On the real thing, the loudness of a note, the amount of reverberation and even the sonic overtones produced depend upon how much pressure you apply

when you tickle the ivories—and when you let off. Many electronic pianos produce the right note when you press a key and make contact, but don't respond to finesse in your fingering.

Technics manages to put nuance in the notes by using digital PCM (pulse code modulation) recording—the same used to store music on a Compact Disc.

The company sets microphones on a 9-ft. Steinway Grand to record the notes digitally—at various velocity levels—then stores this digital data on integrated circuits connected to the keys of the Technics SX-PX1M (\$6200) or SX-PX9 (\$3100).

When you strike a key, sensors tell the microprocessor which key you've hit, how hard, and for how long. The microprocessor then

dips into its library of samples, selects the proper sound and ships it airborne via the piano's amplified loudspeakers. The principal difference between the two pianos is the depth of their microprocessors' libraries. The PX1M boasts keys with up to seven velocity samples; five for PX9.

Being digital, you needn't let the microprocessors as you might the strings on an acoustic piano's soundboard. You can vary their pitch, though, to match that of other instruments in a band. Here's where we get into the electronic abilities of the Technics pianos.

Both keyboards have MIDI (Musical Instrument Digital Interface) inputs and outputs. This means you can hook up the piano to a personal computer, in order to store your composition and see the musical notation on a TV display or printer. The MIDI interface also lets your piano talk to other electronic MIDI instruments. Additionally, the pianos sport a connector for an optional computer floppy-disk drive. With the disk drive hooked up and the proper software loaded, the PX1M and PX9 become player pianos!

SPACE news

Despite signal scrambling by such premium programmers as HBO, there was no shortage of new home satellite TV products at the recent SPACE (Society for Private And Commercial Earthstations) Show in Las Vegas.

In fact, electronics heavyweights Zenith and Radio Shack gave their vote of confidence

Channel Master's new 3-ft. dish (right) for Ku-band satellite TV mounts on walls. Below, Radio Shack's block downconversion receiver is part of a \$2000 do-it-yourself system.

to satellite TV with their first home systems. Other manufacturers introduced sophisticated updates of earlier equipment. Channel Master even unveiled a tiny 3-foot dish for future Ku-band transmissions.

At this writing, there's no clear indication as to which direction most programmers will take regarding scrambling. HBO and Cinemax have begun encoding their signals. Other programmers are fence-sitting until they devise a way to sell entertainment packages to dish owners, as they do to households wired for cable.

Congress is keeping an eye on the situation, but during recent hearings, the lawmakers said they'd let the market develop a solution on its own, and only consider legislation if it seems that dish owners are getting the short end of the stick.

Meanwhile, the Federal Communications Commission has struck a blow for dish democracy. The commission has decreed that local zoning boards can't ban dishes except for "reasonable" health and safety hazards. Now, a satellite antenna can't be treated any differently than a TV antenna. Interpreting what's "reasonable" should make things pretty hot at your next community board meeting, and provide a handsome sideline for lawyers 'til the Supreme Court tunes in.

FM



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Your next outing, take credit for a touch of genius. Take along a Honda portable generator.

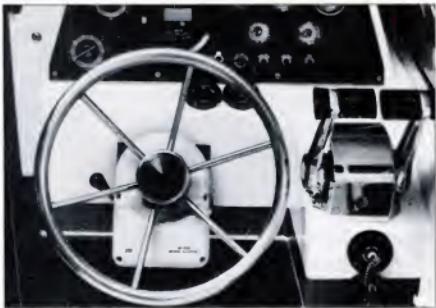
HONDA
Power
Equipment

Outdoors

BY TIM COLE



Who's at the wheel?



King Marine's steering column-mounted autopilot is for small boats.

Up to now, autopilots have been considered rather mystical contrivances designed to guide large power- and sailboats through the sea's assorted treacheries. Buried below deck, they silently manipulate rudderstocks and steering quadrants at the touch of a dial mounted up on the bridge-deck. That means skippers are able to manage the ship instead of merely drive it—overseeing navigation, deck work, even lunch preparation, rather than mindlessly holding a steady course. Recently, the advantages of having an autopilot on board have extended to smaller boats—even center-console fishing boats. The Cannon Helmsman (\$395), for instance, is a remote-control device that gives simple left-right commands to an elemental helm-mounted steering adjustor. If you have to leave the helm to work a fish,

and you want to nudge the boat "over there a bit," you push the left button and the wheel dutifully obeys. The King Marine AP-2000 Auto Pilot (\$695), pictured here, mounts just as simply—just clamp it to the steering column—but it connects to a fluxgate compass, or heading sensor, in the bilge. You dial in the desired course, the heading sensor makes certain the boat is indeed steaming where you want it to and directs the business end of the autopilot to perform course corrections as needed. Both units are interesting examples of large boat "technology trickle-down" that's finding its way aboard smaller vessels.

For more information, contact King Marine, 5320 140th Ave., Clearwater, FL 33520-2846, and Cannon/S&K Products, 1732 Glade St., Muskegon, MI 49441.

Ruger handgun innovation

They're calling this 6-shot revolver the GP-100 (\$340), and it sports a couple of interesting improvements for dedicated handgunners. The cylinder locks fore and aft by way of a bolt/slot assembly at the front of the crane and a pilot bearing at the rear. In addition, the GP-100 grip is a pleasing marriage of synthetics and wood. You get the impact absorption of black rubber without sacrificing the aesthetics. The grip area also houses the mainspring seat and trigger guard latch. Happily, these add-ons have done nothing to detract from the pleasure of firing this well-made Ruger product, as I learned during

a practice session at the Ruger factory. This slightly muzzle-heavy weapon will accept .357 and .38 Special rounds, and for some peculiar reason, I achieved better groups with the heavier loads. See how you do. Contact Sturm, Ruger & Co., Southport, CT 06490.



A contoured grip made of synthetics and wood characterize Ruger's new GP-100 .357.

The fishing boat refined

Grumman's new Pro 16 shatters the notion that there isn't much you can do to improve the typical plain vanilla lakeland fishing boat. You know the type. Manufactured in aluminum. Hard athwartships seating. No room for stowage. Gasoline-tinted bilge water swirling around your ankles. The Pro 16, for intelligent fishing folk, takes this albeit proven hull form and builds in features like a casting platform, livewell, carpeted cockpit and dry stowage. All for under \$2500. Contact Grumman Boats, Marathon, NY 13803.



An Intelligent seating plan and livewells spruce up the Pro 16.

Tent/camper compromise

Full-size recreational vehicles are expensive to operate. Backpacking is a bit crude. The intelligent compromise is the Quickie Camper by MCI Distributors (\$1495). The tent folds out of the bed of a small pickup, covering the bed of the truck and extending to a

4 by 6-foot living area for cooking or socializing. A plywood tent floor is incorporated in the design, which adds insulation and security from creatures of the night. For more information on this basic RV, contact MCI Distributors, P.O. Box 1149, Hillsboro, OR 97123. **PM**



You get shelter, convenience and mobility in the Quickie Camper, the RV alternative.

Homeowners' Clinic

BY NORMAN BECKER, P.E.



Hollow-core door insulation question

I have two hollow-core lauan doors in my house which lead from heated to unheated areas. I would like to insulate these doors by injecting some insulation through a series of holes bored in the hinge side of the door and plugging the holes with dowels.

I can't determine the best insulation for this use. Foam insulation in spray cans is one possibility; however, one door is 36 in. wide and I wonder if the foam would reach the lower areas. Vermiculite is another option. Your ideas would be greatly appreciated.

PAUL BLACKENSTOSE
DOWNTON, PA

You can't insulate hollow core doors the way you suggest. Such doors don't have a large void framed between the face panels. For strength

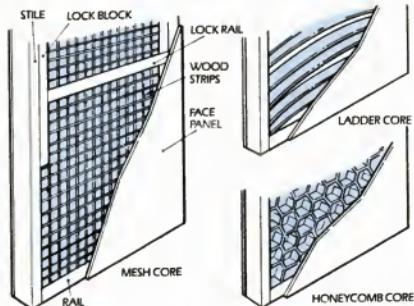
and stability, the panels (which are only about $\frac{1}{16}$ in. thick) are bonded to one of three types of wood or wood derivative cores: mesh (also called cellular), ladder and implanted blanks.

Mesh cores consist of interlocked strips which form a grid throughout the core. Sometimes honeycomb cores are used rather than a grid.

Ladder cores are made of vertical or horizontal strips which are roughly parallel.

Implanted blank cores consist of various shapes: spirals, tubes or honeycombs that may or may not be joined together.

Therefore, injecting foam or pouring insulation will not fill the core. Instead, try covering one or both faces with rigid insulation. For a pleasing appearance, the insulation can be covered with wall paneling.



The interiors of hollow-core doors prevent adding insulation.

Cleaning bricks

How would you clean bricks? The bricks on my front and back porch have little green blotsches of fungus growth.

F.S. FORKE
MANVILLE, NJ

The growth you refer to may be moss, which often grows on masonry surfaces that are damp and not exposed to sunlight. The moss can be scrubbed off with household bleach. Remove bleach residue left on the bricks by rinsing thoroughly. Common bleach usually works fine, but if your bricks need stronger treatment, try a weak weed killer or ammonium sulfate.

The Brick Institute of America, 11490 Commerce Park Dr., Reston, VA 22091, publishes a good booklet (technical note No. 20, 75 cents) that discusses cleaning a variety of stains from brick, ranging from grease to smoke residue.

Peeling patio

I have a concrete patio which I have painted four times, twice with water-based paint and twice with oil-based paint.

After people walk on the patio, I wash it with plain water. The next day, the paint lifts. Also, I thoroughly washed the patio with soap and acid. I even gave it two coats of water-repellent solution.

Please tell me what I am doing wrong and what kind of paint will stay on concrete.

M. LEVI
LOS ANGELES, CA

Putting the oil-based paint on the concrete was a mistake. For one thing the oil reacts with the lime in the concrete and forms a soap which becomes soluble and loses bond. Also, the problem was compounded by putting a latex paint on top. The oil paint is fairly flexible but the latex is fairly rigid. The differences in expansion and contraction between the two causes the latex to crack.

It would be best to remove the four layers and repaint

the patio. You can use a water-emulsifying paint stripper, which can be removed by washing off after it's applied, such as the one made by Red Devil.

Once the paint has been removed, the concrete should be rinsed thoroughly and allowed to dry. Repaint it with two coats of chlorinated rubber-based paint for swimming pools. The first coat should be thinned, so it penetrates and acts as a primer. Follow it with a full-bodied second coat.

You can get the solvents for thinning the paint from your local paint dealer. The solvent will probably contain Xylol or Toluol; both are flammable hydrocarbons, so be careful handling and storing them. A latex paint, which is easier to use, isn't as durable and will wear rather easily compared to the chlorinated paint.

Dirty roof

My home's roof is covered by asbestos-cement shingles that are 13 years old. Originally white, they are now dark gray with mildew. How should I clean them?

ROLAND L. LAFLEUR
PELOUSAS, LA

Aside from the mildew, the shingles' surfaces probably have been darkened by airborne dirt. One way to clean them is to use a solution of $\frac{1}{2}$ cup trisodium phosphate (such as Soilax), $\frac{1}{2}$ cup of laundry detergent and one quart of household bleach. Add enough warm water to make one gallon of solution.

Wear rubber gloves to protect your hands and observe all safety precautions while working on the roof. Asbestos shingles are brittle, so be careful not to crack any. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.50 postpaid. Send your orders to Popular Mechanics, Box 1013, Radio City Station, New York, NY 10101.

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Car Clinic



BY MORT SCHULTZ

A glassy act

An auto glass shop in my area wants nearly \$100 to remove the windshield of my car, a 1984 Ford Escort, and seal the area to stop a water leak. Can you suggest a way for me to do this repair job myself?

THOMAS ARNSBACK
COLLEGE PARK, MD

If you're certain water is leaking from around the windshield, sealing gaps is not usually that big a deal. The windshields of many newer models have a urethane seal that virtually binds the windshield to the body flange, making the glass a structural part of the car instead of a separate unit. This makes it unnecessary to take the glass out to plug a leak.

Get a trim molding removal tool and slide it under the molding until it strikes the molding retaining clips. Twist the tool and the molding will pop free.

You will also need butyl windshield adhesive sealer and liquid butyl afterseal to do the repair. These products can be purchased at a store that sells automobile glass supplies.

Here are the steps to follow after removing the trim molding:

1. Inspect the urethane sealer around the outside edge of the glass for breaks.

2. When you find a suspicious area, spread a 4- to 5-in.-long bead of butyl adhesive sealer at the edge of the glass.

3. Use a thin plastic or wooden implement, such as

a clean Popsicle stick or coffee stirrer, to push the butyl adhesive sealer into the gap.

4. Apply a thin coating of liquid butyl afterseal to the butyl adhesive sealer. The afterseal softens the sealer, causing it to swell and fill the gap. That's all there is to this fix.

Important: Using butyl adhesive sealer without the liquid butyl afterseal is a waste of time and effort. Butyl adhesive sealer by itself won't seal a thing.

No offense meant, Mickey

I want to suggest that you alert owners of 1982 Dodge D-10 pickup trucks equipped with the Mitsubishi 2.6-liter engine to a serious matter

that could ruin their engines. About 1 1/2 years ago I got a recall notice to have a plug at the rear of the valve cover rescrewed. Resecuring involved a dealer mechanic removing the plug to slap some adhesive on it.

While driving recently I noticed a drop in oil pressure. I immediately stopped the vehicle, opened the hood and found oil all over the firewall and dripping down to the road. The dipstick showed that the crankcase was empty. I also discovered that the valve cover plug was missing.

To make a long story short, I called my wife and we retraced the route I'd been driving. We found that black plastic plug, with the glob of tan adhesive still stuck to it. It was then that I noticed there's no flange on the plug to keep it in place, adhesive or not. Chrysler must be slipping when it puts out such a Mickey Mouse repair for such a critical oil-retaining part.

JOHN B. LITTLEFIELD
BELLE HAVEN, VA

You've been warned, owners of similar vehicles with 2.6-liter engines. It would be a good idea periodically to see that the valve cover plug is still securely attached to

the valve cover. If it was installed correctly, using the specified high-strength epoxy and thoroughly cleaning both surfaces, the plug should stay put.

Cosmetic surgery

Last week I looked under my brand new 1986 Ford Tempo and got the shock of my life. Although the car had been driven only 515 miles, many of the components, including shocks, coil springs and oil pan, were covered with rust. I drove to the dealer who told me not to worry—that this was normal and the parts weren't really rusted. He called it surface discoloration and said it won't harm anything. Is he correct? I need peace of mind.

FRANKLIN BARON
BETHLEHEM, PA

Rust is rust. However, this rust won't accelerate to cause parts to eventually deteriorate or affect performance.

"Cosmetic rust," let's call it, occurs mainly to cars that are kept in storage for long periods before they're sold. Your dealer could have treated affected components to get rid of rust before he turned the car over to you. If it's upsetting you, ask him to

(Please turn to page 24)



Nuts about grease

According to Tony Alico Jr. of Brooklyn, New York, he's never had trouble getting lugnuts off the wheels of his car. No jumping up and down on the lug wrench or using a 6-ft. extension pipe for Tony. That's because he takes the lugnuts off every year, smears some lithium grease around each wheel stud and runs the nuts back up. This spreads grease over the threads of the nuts and studs. The well-lubricated hardware never freezes together, thus never giving Tony a hard time when he has to remove a wheel. Antiseize compound should work, too. If lugnuts are



properly torqued, they do not need corrosion to hold them in place.

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Now you can enjoy savings as well as extra motor oil performance from Mobil—the oil used by the 1985 SCCA Endurance Cup Champions! We'll send you a \$3.00 cash rebate when you mail proofs-of-purchase of 5 quarts of Mobil 1 Motor Oil, or a \$1.25 cash rebate when you mail proofs-of-purchase of 5 quarts of Mobil Super or Heavy Duty Motor Oil. See details on Certificate.

SWEEPSTAKES OFFICIAL RULES—NO PURCHASE NECESSARY

1. You are automatically entered in the Mobil "Great Corvette Giveaway" Sweepstakes when you mail your request for the Mobil "Great Oil Rebate" using this certificate. Due to State laws, rebate certificates obtained at service stations will not be accepted. Requests for rebates must be sent to: Mobil 1, P.O. Box 4537, Redsville, NC 27322-4537, Massachusetts, New Jersey, Maryland, Virginia and Nevada.
2. If you do not wish to qualify for a rebate, but want to enter the sweepstakes, you may enter by completing this certificate or by simply hand-printing your name, address and zip code on "Mobil 1" on 3" x 5" pieces of paper. Mobil 1 Sweepstakes Giveaway Sweepstakes, P.O. Box 4537, Redsville, NC 27322-4537, for Vermont residents only. "Great Corvette Giveaway" Sweepstakes, P.O. Box #4532, Redsville, NC 27322-4532. Enter as often as you wish, but each entry must be mailed separately and postmarked by July 21, 1986. Mobil Oil Corporation will not be responsible for late, misdirected, lost or stolen entries. Vermont residents will have priority in the drawing for the Corvette.
3. Mobil Oil Corporation will award the following prizes in this promotion: One Grand Prize—Custom 1986 Mobil 1 Corvette Corvette with standard equipment, including: V-8 engine, air conditioning, power steering, power brakes, power windows, Eagle GT tires, and AM/FM stereo radio (\$30,000 Value); ten First Prizes—Custom Mobil 1 Corvette Mini-Car (\$700 Value); and one thousand Second Prizes—Custom Mobil 1 Radio-Controlled Racer with battery-operated remote control (\$48.95 Value)—4 AA 1.5V and 4 C-cell 1.5V alkaline batteries not included.
4. During the week of August 18, 1986, winners will be selected at random from all valid entries received, by Glendinning Associates, Inc., an independent judging organization whose decisions are final on all matters pertaining to the Sweepstakes. The names of the winners will be published in the "Mobil 1" catalog. Winners will be required to sign and return within 30 days of notification, a form certifying their eligibility for participation in this promotion and release regarding prize awards. In the event of non-compliance with the 30-day time period, an alternate winner will be selected. All prizes will be returned to the sponsor or to Glendinning Associates, Inc., as undeliverable and will be destroyed. All prizes are non-transferable and non-refundable. Taxes on prizes are to be paid by the winner. No substitution is allowed. Dealer prep charges, shipping and handling are not included. Prizes are not transferable and no validation for prize shipment. Taxes on prizes are the sole responsibility of the winner. The odds of winning are determined by the number of entries received.

5. Mobil 1 Sweepstakes Giveaway Sweepstakes is open to licensed drivers who are residents of the U.S., except the employees and their immediate families of Mobil Oil Corporation, its subsidiaries, agents and Glendinning Associates, Inc. This offer is void wherever prohibited or restricted by law and subject to all Federal, State and local laws and regulations.

6. For the names of the Grand and First Prize winners, send a self-addressed, stamped envelope to "Great Corvette Giveaway" Sweepstakes Winners List, P.O. Box 4537, Redsville, NC 27322-4537 by August 8, 1986.

MAIL-IN CERTIFICATE

To receive your Mobil Rebate, check the appropriate box.

Send me a \$3.00 rebate. I have enclosed 5 proofs-of-purchase (aluminum seals) from 5 quarts of Mobil 1 Motor Oil (plastic only), and a dated original proof-of-purchase receipt with the price of the oil circled. To remove the aluminum seal from the plastic bottle, cut the seal inside of the necks carefully with a single-edge blade. Record the UPC Code number in the space provided below.

Send me a \$1.25 rebate. I have enclosed 5 proofs-of-purchase (5 UPC Codes fiber container) or 5 aluminum seals from 5 quarts of Mobil 1 Motor Oil (plastic only), and a dated original proof-of-purchase receipt with the price of the oil circled. To remove the 5 UPC Codes from the fiber containers, simply cut around the symbols carefully with a single-edge blade. To remove the aluminum seals from the plastic containers, cut the seals inside of the necks carefully with a single-edge blade. Record the UPC Code number in this space provided below.

Fill out this coupon and mail it with your proof-of-purchase UPC Codes, aluminum seals and receipt to:

MOBIL REBATE, P.O. Box 4537, Redsville, NC 27322-4537

Rebate requests must be postmarked no later than July 21, 1986.

NAME _____

STREET _____

CITY _____

APT # _____

STATE _____

ZIP CODE _____



Rebate applies to all viscosities—
plastic and fiber containers

UPC CODE NUMBER _____
Response to the following question is voluntary. Is this your first purchase of Mobil Oil? YES NO
Additional offer terms: LIMIT ONE REBATE PER HOUSEHOLD. NO GROUPS OR ORGANIZATIONS. Rebate requests must be made in the name of the individual consumer. Rebate requests for purchases must accompany each rebate request. Allow 6-8 weeks for receipt of your check. One void where prohibited by law. restrictions apply.

CAR CLINIC

(Continued from page 22)

do it now. Tell him to call the Ford regional office to get authorization, so the cleanup bill will be picked up by Ford.

Thought process

I have a 1985 Pontiac 6000 LE wagon that has a buzzing noise which sounds like marbles rattling in a tin can. It's coming from the back of the vehicle and is most noticeable when the engine is idling. The dealer thought it was a broken baffle in the gas tank, but a new tank hasn't helped. I think it's the fuel pump. What do you think?

KEN JONALITIS
LOS ANGELES, CA

I think like you think. It's the fuel pump.

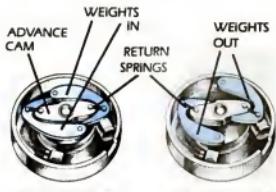
This noise is striking a multitude of 1985 GM A-Body model station wagons—your Pontiac 6000 Wagon, Chevy Celebrity Wagon, Olds Ciera Wagon and Buick Century Wagon. Replacing the fuel pump probably won't help, because it doesn't seem to be the pump per se that's noisy, but the way the pump sits in the gas tank. General Motors service engineers are working on the problem, so there is currently no



Another spark knock gremlin

A lot of money and time has been lost trying to cure spark knock problems. Because there are so many things that lead to the hot spots and high combustion temperatures that cause this common and destructive problem, cures are elusive. One of the more common causes of spark knock is excessive total advance. But excessive total advance may not always be the result of misadjusted timing. A couple of our mechanic friends report having cured serious spark knock on a number of cars, primarily GM models, by freeing-up stuck centrifugal advance weights.

Centrifugal advance weights are those wing-shaped plates of steel found within the distributor and, on most GM engines, directly under the rotor. These weights swing out as engine speed in-



creases, turning the distributor's pickup mounting plate or breaker plate and advancing timing.

If the weights stick, timing will remain advanced when engine speed drops. When the next heavy load/low engine speed driving situation is encountered, the engine rattles like it's trying to shake its connecting rods loose. (It is!)

To cure this condition on cars with the plate mounted right below the rotor, just remove the cap and rotor, clean the centrifugal weight mechanism and apply a thin coating of Lubriplate to all contact areas. If the springs that pull the plates back to the low-speed position are worn, they should be replaced.

GM's 2.5-liter engine

I have had a great number of problems with my 1984 Chevrolet Celebrity 2.5-liter engine, including the cracked

solution. You'll have to put up with the noise until they find out how to get rid of it, at which time I'll let you know through Car Clinic.

Essential Tools For Your Garage.

You know the value of having the right tools for the job at hand.

Easy-to-use, easy-on-the-pocketbook Berryman products are your blueprint for maximum performance.

Berryman's B-12 CHEMTOOL CARB/CHOKE SPRAY dissolves varnish and gum build-up on the carburetors, choke shaft and linkage of all gasoline-operated engines.

No shop is complete without it. Berryman products are guaranteed. So ask for them wherever you shop for parts.



Guaranteed Quality Since 1918
3800 E. Randol Mill Rd.
Arlington, Texas 76011



block condition mentioned in your August '85 column (page 37). As you said would happen, the company replaced the engine to get rid of that problem. But the new engine has given other troubles, including noisy timing gears that were replaced and are still noisy, a warped cylinder head, and noisy lifters that were replaced and are still noisy. The latest problem has been a loud and persistent spark knock. GM fixed it by installing a thicker head gasket, but now the car can't get out of its own way. Performance is so sluggish as to be nonexistent. Is there no solution except to junk this bucket of bolts?

R. A. BUCHHOP
PERRYSBURG, OH

The upshot of this mess is that you got a bad first engine. Apparently, you also got a bad second engine.

Concerning that cracked block, GM admits that the possibility exists for this to happen to all 400,000 owners of 1984-model cars with 2.5-liter engines. Indications that a crack has developed are loss of coolant and the presence of coolant in oil.

Models affected are Chevy Celebrity, Citation and Camaro; Buick Skylark and Century; Oldsmobile Ciera and Omega; and Pontiac 6000, Firebird, Fiero and Phoenix. The company has agreed to provide free engine replacements for five years or 100,000 miles to

SERVICE TIPS

- You guys driving 1985 and early production model 1986 Dodge Ramcharger 4-wheel-drive vehicles ought to keep an eye on the front axle vent on the left side of the axle housing. Some have developed lubricant leaks. To correct the trouble, a new vent has to be tapped into the housing and the old vent plugged. The job, a freebie, is outlined in technical service bulletin (TSB) 02-12-85.
- Does your 1985 Pontiac 6000 equipped with a 2.5-liter engine and 125C transaxle have an unexplained vibration in the steering wheel, instrument panel, seat and floor at 55 to 70 mph? Does the vibration cease when you apply the brake pedal? The cause may be the alternator belt. If it's a cogged belt, have it replaced with a noncogged belt (part No. 22514316).
- The answer to stopping that pulsation you may be feeling when applying the brakes of a 1984 Toyota Tercel is to install newly designed front brake pads (part No. 04491-12241). When you do, have the rotors resurfaced or replaced, if necessary.
- If the battery on early '86 Nissan Maximas keeps running down when the car is driven at low speeds or idled for extended periods with the a/c on, install a smaller diameter alternator pulley (part No. 23150-26E00) and a new fan belt (part No. 11720-16E02). TSB TS86-008 says so.

owners whose engines develop cracked blocks during that period.

But what do you do if the second engine gives you fits? If it cracks you might be okay, because you'll still be able to get another new one. Under the circumstances, however, all I can suggest is that you continue complaining to the dealer and Chevrolet regional representative until the second engine is fixed to work the way it should, or someone in power agrees to replace it.

Perhaps the real cause of the spark knock problem was not uncovered. A complete diagnostic check, including the EGR, EFE and intake hot air

systems, should have been performed. Reducing engine compression ratio with a thick head gasket frequently leads to a loss of power. A switch to high-octane unleaded gas is usually a better solution when normal troubleshooting fails to solve the problem.

Obviously, if you want to pursue the matter to its ultimate, there's always litigation.

DO YOU HAVE A CAR PROBLEM?
Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 221 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

PM

YESTERDAY IT WAS CHLORDANE. TODAY IT'S ORTHO-KLOR.

ORTHO-KLOR Soil Insect & Termite Killer is a concentrated liquid insecticide from ORTHO that will kill all the insects that Chlordane was originally used to control and is especially effective against tough-to-kill ants and termites.

Since it contains the broad spectrum, professional insecticide Dursban, you can count on ORTHO-KLOR to control the major outdoor home pest invaders quickly and effectively.

ORTHO-KLOR Indoor & Outdoor Insect Killer is a milder, general-purpose insecticide dust that kills pests inside and outside your house. Use it to kill most nuisance pests including roaches, ants, spiders and fleas and many others in and around your home.

ORTHO-KLOR, the powerful replacement for Chlordane that gives you so much more.

Avoid accidents. For safety, read the entire label including precautions. Use all chemicals only as directed. Copyright © 1986 Chevron Chemical Company. All rights reserved.



ORTHO

Chemical
Company



ORTHO WORKS WONDERS

ORTHO-KLOR



Get a taste of it.

Merit

The low tar flavor break.



Joyride.

Kings. 8 mg "tar," 0.5 mg nicotine av. per cigarette, FTC Report Feb. '85.

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

© Philip Morris Inc. 1985

Appliance Clinic



BY STEVE TOTH

Balky stove igniters

I own a Magee liquid-propane gas range, model No. LYN73, UGW-11, serial No. S04420. The electronic ignition worked fine when new but now, during wet weather, it doesn't. I have to use a match to light the oven. Next, the burner igniters did the same thing. During periods of high humidity, none of the igniters work.

JAN MAGNUSSON
NORTHRIDGE, MA

Your range may have bad electrical contacts in the top burner switches or the oven igniter switch. When you turn a burner knob to the light position or set the oven thermostat dial, you open an electrical circuit. This activates the electronic spark module, producing a spark at the top burner or oven igniter.

A little moisture and grease from cooking may have created a grease film on

the electrical contacts. This could account for the range's erratic operation.

To check the switches, disconnect the range's power. Remove the four burner grates, the aeration pans and the control knobs. Prop up the top with its support rod. The top burner switches, on the oven's right side, are mounted on top of each burner's gas valve and are loosely held on with a nut. The oven thermostat igniter switch is mounted on top of the thermostat by two small screws. Each switch has two wires attached.

Test each switch with a flashlight continuity tester. Start with the burner switches. Gently pull off both wires and remove the hold-down nut. Lift the switch off the gas valve stem. Place a lead from the tester onto each wire terminal. Check your continuity tester: you have a closed switch if its light is

on. (You may expect the opposite, but this is how this model's switches work.) Rotate the center section of the switch until it hits maximum travel. This should be the light position; its contacts are open and the light should be off. Test all burner switches this way.

Next, pull the wires off the oven thermostat switch and attach the tester leads to each terminal. It should test in the same manner as the burner switches. The light is on if the thermostat is off and its contacts are closed. Dial the thermostat to any setting and the light should go off. Quickly turn the thermostat off and reattach its wires. Note: A small amount of gas will flow into the oven during this test, so turn the thermostat off as soon as the switch is checked.

Reinstall the burner switches and finger-tighten their hold-down nuts. Obtain replacement switches for those that tested bad or are badly worn by writing the Boston Stove Co., Box 1002, 155 John St., Reading, MA 01867. Include the range's serial and model numbers. A burner switch, part No. 83E4424 is about \$5; an oven igniter switch, part 73E4437, is about \$9.

Refrigerator fix

I have an RCA Whirlpool gas refrigerator with a Servel burner, serial No. 804628. I have a place in the mountains and have invested

in this refrigerator to the tune of \$400. It has a natural-gas main orifice and turbulator, but I need to switch it to a bottled-gas main orifice and turbulator.

MATTHIAS K. HACKL
HATTFIELD, PA

Contact Kern's Gas Refrigeration Co., 3929 La Mesa, Central Valley, CA 96019; (916) 275-2045. They have compiled a short service manual that may be of interest to you. It's called Servel Whirlpool 1933-1957 Gas Refrigeration Repair Manual. In order to get the right parts, supply Kern's with the refrigerator's model number, its BTU input and tell them the altitude at which it will be operating.

Service tip

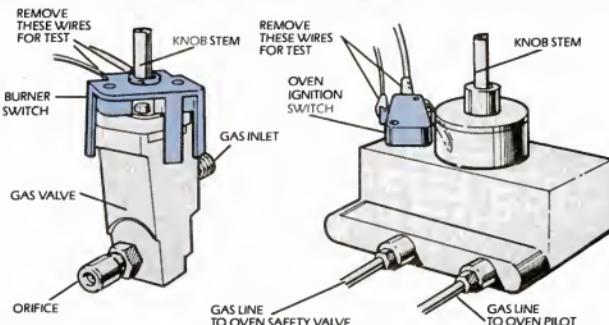
Now that summer's here, we'll need our air conditioners. If you are shopping for a new one, jot down these facts: the size of the room to be air conditioned, how many windows it has, if it's insulated and the available voltage (120 or 240 volts). These facts will help you choose the right unit.

An air conditioner's BTU (British Thermal Units) tells you the amount of heat the unit removes in one hour. The larger the BTU rating, the more cooling power it has. Remember, bigger isn't always better. A unit that's too big for a room will give it a clammy feeling and one that's too small won't cool adequately.

An air conditioner also has an EER rating (Energy Efficiency Ratio). This rates the amount of cooling it does in relation to the electricity it uses. The higher the EER, the greater the efficiency.

Remember to clean an air conditioner's filter frequently. Be sure windows are closed while it's on and close blinds on the sunny side of the house. **PM**

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 37th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.



Remove the two wires on each burner switch and on the oven ignition switch to test continuity.

Computers



BY RON SCIBILIA

MacEvolution

Since its introduction 2½ years ago, Apple's Macintosh has played Carmen to the computer world, inspiring intense but divergent emotions in those who follow the scene. As advanced and appealing as the Mac might be, it has always been viewed more in terms of its potential than its present capabilities.

For this reason, Mac's latest incarnation—the Macintosh Plus—will disappoint as many people as it satisfies.

Evolutionary but not revolutionary, the Macintosh Plus carries the basic Mac design concept another step forward in power and utility. But it won't quiet Mac zealots seeking the Ultimate Machine to capsize IBM's PC and Commodore's Amiga.

Given the well-known

wish lists of Mac supporters, the Mac-Plus is as notable for what it *isn't* as for what it is. There's still no color output, no easily accessible internal expansion slots for add-in boards. Nor is there an upgrade in horsepower from the original Macintosh powerplant, the Motorola MC68000 microprocessor.

This said, the Mac-Plus is nevertheless an extremely strong performer. It demonstrates not only how far the microcomputer has come in a very short time, but also Apple's determination to correct the shortcomings of earlier Mac designs.

Among its improvements, the new Mac boasts faster processing, more internal memory and more data storage on disk. The versatile new keyboard has both numeric keypad and arrow keys. Moreover, the Mac-Plus offers greater flexibility in hooking up peripheral devices. A lot of these improvements are already available from outside vendors, but now Apple itself has

Apple's Macintosh Plus offers more flexibility for add-on peripherals.



welcomed these enhancements aboard—along with the blessing of the Apple warranty.

For internal RAM (random-access memory) you now get a full megabyte—1 million characters. You can expand internal memory on the Mac-Plus to 4 million characters.

Meanwhile, the new Mac's 3½-in. microfloppy disk drives give you twice the storage capacity of the original—800,000 characters per disk, or about 400 double-spaced pages of text.

Underscoring the compa-



DEGAS, from Batteries Plus, is

ny's realization that the Mac system must be opened up if it's to prosper long-term, Apple has added a new connector on the Macintosh Plus's back panel. This makes it easier for third-party hardware suppliers to link up high-speed, high-capacity storage systems such as hard disk drives and tape backup systems. This SCSI (Small Computer System Interface) parallel port transfers data up to five times faster than the Mac's serial port.

Apple has also boosted the Mac-Plus's speed by revising the Mac's operating system software and fundamental graphics routines. This is done with a new 128K ROM (read-only memory) chip that's twice the size of the original Mac's. The re-worked chip offers RAM "caching" that cuts disk access time—and thereby increases functional speed—by storing often-used program chunks in internal memory.

What's the price for progress? The Macintosh Plus carries a suggested retail tag of \$2599, but the new unit doesn't come with the popular MacWrite and MacPaint

programs as earlier Macs did. The Macintosh 512K, which does include both programs, is still available, its price now cut from \$2499 to \$1999. You can upgrade an older Mac to Plus status with a new keyboard, disk drive and logic board kit. This will cost approximately \$1000 for the Mac 512K, or \$1200 for the 128K version.

Digital Degas

Another RAM millionaire in the personal computer world is Atari's new 1040ST, a more powerful addition to the California supplier's ST



for the artsy Atari ST micro.

line of microcomputers. For raw power on the cheap, the 1040ST—sporting a megabyte of RAM—is in a class by itself.

The system costs \$1000 with a high-resolution monochrome monitor. With a color CRT it's \$1200.

Atari claims that 250 software titles are now available for its new micro, with programs in a wide variety of applications. Canadian software publisher Batteries Included has a powerful and low-cost (\$40) painting program called DEGAS (for Design and Entertainment Graphic Art System) that showcases the graphic talents of this Maserati-for-the-masses.

DEGAS includes a palette of over 500 colors, works in all three Atari ST resolution modes, and has 15 built-in brush patterns. The program, which makes use of the GEM graphics interface, has 60 pre-designed patterns ready for you to draw on, and features mirror, shadow and airbrush techniques. You can combine text with graphics; the program includes one font, plus the capability for custom-designing others.

Save Gas, Save Engine with "POLY"

The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!

The Secret is "Poly"

"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guiness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved It True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road: The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

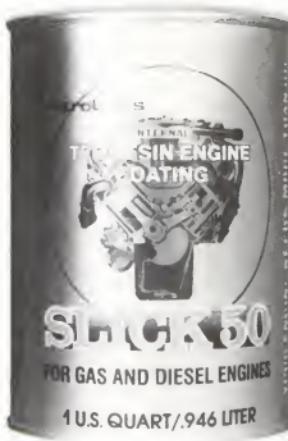
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The senior engineering researcher at a leading southern California university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnedish into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)

3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine

4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

Profit from Selling Slick 50 Yourself

Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information call toll-free 1-800-525-8624, ext. 6 (in Colorado call 1-303-762-1385) or send to: Progressive Energy Corp., 3148 South York Street, Dept. PM686, Englewood, Colorado 80110.

Yes, I want to improve my car's performance and save my engine — rush me risk free

One Slick 50 at \$39.95 + \$4.00 shipping and handling.

Give me free shipping and handling for my order of 2 or more at \$39.95 each.

Check C.O.D. Visa/MasterCard

Card # _____

Exp. Date _____

Name _____

Address _____
(Give street address if possible for UPS delivery)

City _____ State _____ Zip _____



Progressive Energy Corporation

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Freewheeling

BY WADE HOYT



Snow fooling around



Car with traction control out-drags wheel-spinning competitor.

Arjeplog, Sweden, is a tiny village of some 2000 inhabitants, located just below the Arctic Circle in Lapland. It has neither an airport nor a railroad. What it does have is a seemingly endless winter, bitter cold, and the deepest lake in all of Sweden (Lake Hornavan, at 603 ft.).

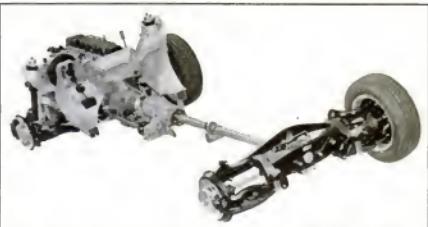
As soon as the ice on Lake Hornavan gets 3 ft. thick, the auto, truck and tire manufacturers of Europe flock to Arjeplog to do winter testing on "tracks" plowed through the snow on the ice.

In 1972, Mercedes was the first carmaker to come to Arjeplog, using the frozen lake to develop its antilock brake system (ABS).

This winter, a small group of auto journalists squeezed into three helicopters for the

last leg of a long journey to Lapland to try three of Mercedes' newest car control innovations: an automatic locking differential, acceleration skid control and an automatically engaging 4-wheel drive (4MATIC).

A conventional limited-slip differential uses spring-



4MATIC sends $\frac{1}{2}$ of the power forward, $\frac{1}{2}$ to the rear wheels.

loaded clutches to limit wheelspin when one wheel is on a slick surface. In the Mercedes system, the clutches are applied hydraulically when a wheel begins to spin. The clutches are automatically disengaged at speeds over 25 mph, when the gas pedal is released, or when the brakes are applied, to avoid the squirrely handling of conventional limited-slip rear ends under these conditions.

The acceleration skid control system is even more effective for preventing wheelspin on slippery surfaces. The same wheel sensors that detect lockup in the ABS brake system are used to detect wheelspin on acceleration. The brake is immediately applied to the offending wheel or wheels to reduce spinning. If that doesn't do the job, a second control loop reduces engine torque by overriding the gas pedal signal in the car's "drive-by-wire" electronic accelerator. The engine does not rev up even if the gas pedal is floored, the wheels do not spin, and the car won't fishtail.

When Mercedes set out to develop a 4wd system, they

felt obliged to outdo the competition. 4MATIC is a part-time 4x4 system that is engaged automatically when wheel sensors detect any slip or spin. If wheelspin continues, even with 4wd engaged, first the central differential and then the rear differential are automatically locked. All this takes place within split seconds, with no decisions or action required by the driver. Every few seconds the system shifts back into 2wd to check traction conditions. It's uncanny; the system is so smooth you can't feel the 4wd or differentials engaging.

This is, perhaps, the only drawback to any of these clever systems: they give the driver such a feeling of confidence that it's easy to get cocky and steam into a turn much too fast. To help avoid this, a warning light on the dash comes on when one of these systems is engaged, informing the driver that he is approaching the road's limit of adhesion. The message is clear: slow down, stupid! As we found on Lake Hornavan, if you ignore the idiot light you're likely to leave big, Mercedes-shaped holes in the snow banks! **FM**



Car with 4MATIC (right) tracks safely around an icy turn while rear-drive car begins to spin out.



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EXCEEDS THE NEED



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Moving ahead to the rear, you'll notice the roofline is lower. Inside, however, you'll find more headroom. That's perfectly logical. Honda

engineers choose to give room to people by giving less room to the car.

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Since the suspension is derived from many years of racing experience,

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ture is full dictions.

you might deduce that the handling is an exhilarating experience. You would be correct.

The Accord DX Hatchback shown here comes with rear seatbacks that split vertically for versatility. It has thirty-seven percent more cargo area. And there is a rigid cargo area cover. The steering wheel adjusts. Panel switches

work with a touch. And new front seats with adjustable headrests offer better support.

For your convenience, we have included a quartz digital clock. It will keep an accurate account of the good time you will have while driving the new Accord. Nothing contradictory about that.

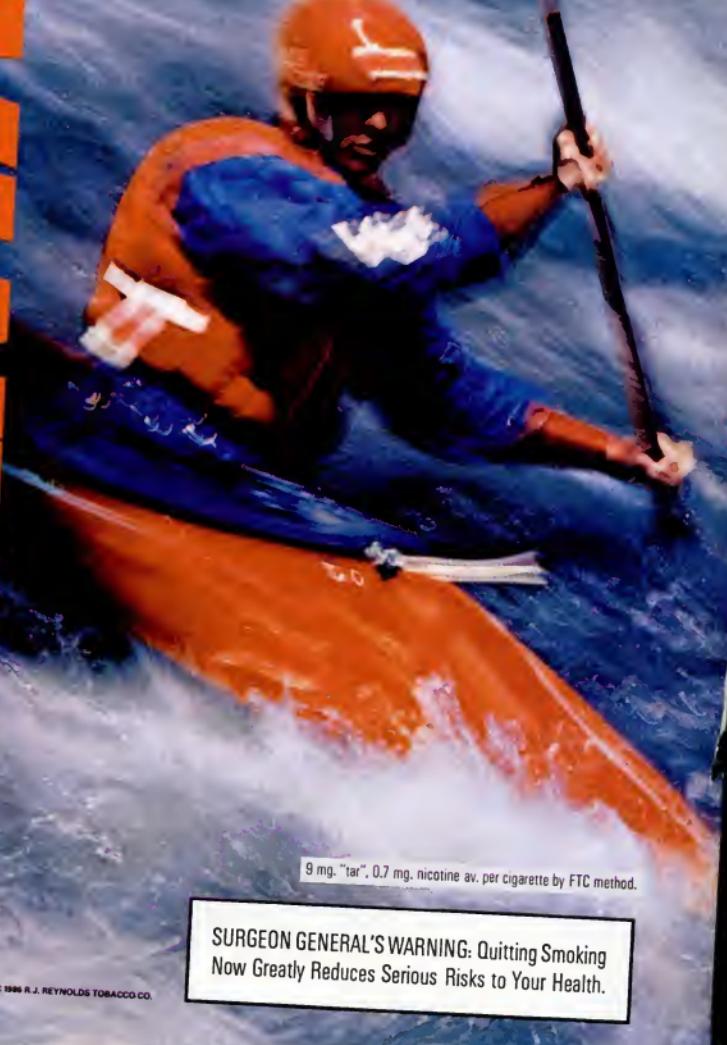
HONDA

The New Accord



VANTAGE

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THE THRILL OF REAL CIGARETTE TASTE IN A LOW TAR.



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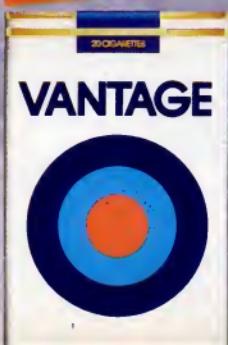
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Audio

BY TERRY SHEA



The big broadcast

Have you ever scanned through the FM band of your stereo tuner or receiver and come across something you want to hear, only to find the music obscured by gobs of irritating hiss? I have, and I know it's maddening. The only solution is to switch to mono reception, which clears up the signal nicely—but you give up stereo's depth of image. Why can't we have both a clean, noise-free signal and stereo reception?

Well, it won't be long before we can, thanks to a new process developed by the CBS Technology Center. It's called the FMX Extended Range FM Stereo System, and it reduces the noise in stereo FM broadcasts while increasing their range to that of mono transmissions. In other words, the improvement you'll hear with FMX over today's FM stereo per-

formance is comparable to the difference that currently exists between mono FM performance and FM stereo performance.

The noise we presently put up with when listening to FM stereo is inherent in the standard FM stereo broadcasting system adopted by the Federal Communications Commission back in 1961. There are several ways to broadcast FM stereo, but to avoid chaos, the U.S. uses a single system for all stations and receivers. Otherwise, not all receivers and tuners would be able to receive all FM stereo stations. But the system's performance could be better.

The noise culprit when listening to stereo FM is the stereo portion of the transmitted FM signal. FM stereo broadcasts are split into mono and stereo segments,

and by the nature of our FM system, the stereo portion of a transmission is noisier than the mono portion.

What CBS does with FMX is to transmit a different, additional stereo signal that has been compressed, or put in a form that can be broadcast with less noise. At the receiving end (your stereo receiver or tuner), the FMX signal is expanded or restored to its original form—without the noise that would have accompanied it had it been transmitted in the conventional manner. In electronics jargon, this process of complementary compression and expansion is called signal companding.

Of course, a receiver or tuner that doesn't have the circuitry to expand (or decode) the FMX signals would sound awful trying to reproduce FMX. So the normal stereo signal must also be transmitted exactly as it is at present, without FMX. FMX-equipped receivers or tuners, when they're available, will automatically detect the presence of an FMX signal and switch into the FMX receiving mode. At the same time, conventional non-FMX receivers will remain unaffected.

FMX is particularly impressive. In a recent demonstration, a laboratory transmitter was used to broadcast a weak signal that delivered virtually unlistenable stereo. But when FMX was used, the signal became very listenable.

The effect was even better on those FM stereo signals that were listenable but noisy. FMX wiped away the noise, and there was no audible benefit in switching to mono. What's more, FMX promises to significantly reduce what's called "picket fencing" in car stereo FM reception—those irritating jabs of noise that hit in rapid succession.

Okay, so FMX is a miracle worker when it comes to cleaning up FM stereo reception—what's the catch? The catch is that FM stations must broadcast using FMX-equipped stereo generators,

which are not yet available, and our receivers and tuners need FMX decoding circuitry, not found in any currently available products.

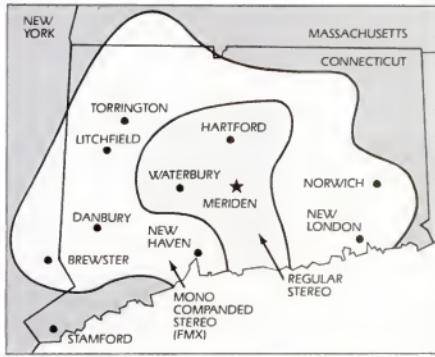
The situation is likely to change over the next six to nine months, as generators become available and FMX-equipped stereo components are introduced. The word from CBS and the National Association of Broadcasters (which worked with CBS on FMX) is that FM stations are very interested in FMX. That's because it enlarges the area over which a station can broadcast a high-quality FM stereo signal, and thus should be appealing to advertisers. A representative of a stereo generator manufacturer says stations can convert to FMX for less than \$500—a relatively minor investment for commercial FM broadcasters.

With broadcasters coming on line later this year, it's now up to stereo companies to begin making receivers and tuners with FMX decoding circuitry. This, too, seems to be under way.

NAD was the first company to announce plans to deliver an FMX-equipped tuner. It should be available by the time you read this, at a suggested retail price of \$500. Other component manufacturers have shown interest, notably Denon, Kenwood and Tandberg, but no definite product introductions have been announced.

More definite product announcements should begin when the FMX decoding circuitry is available as a micro-processor chip—that marvel of electronics circuitry miniaturization. Once this happens, the manufacturer's cost of adding FMX to a product will likely be less than \$2.

Because of space limitations, such a chip is the only way that FMX can be incorporated into car stereo products. The good news is that the availability of an FMX chip is expected shortly. So by the time you read this, they might already be available for the new model year products.



Motorsports

BY STEVE POTTER



Gentlemen, start your PCs



Computer interface on rollbar shows that student is not alone.

Driving a race car is easy. It's driving it fast that's difficult. Racing schools in Europe and the U.S. have made an art of introducing aspiring competition drivers to the tools of the trade. Instructors are current or former racers who have, hopefully, a gift for teaching. The instructor can tell a student what to do, and even demonstrate how it's done. But there's a built-in communication problem because the instructor is trying to teach something that isn't fundamentally verbal.

In a racing school, the situation is complicated by the fact that most of the action takes place in single-seat Formula Fords, some distance from the instructor's keen eyes.

Recently, the Skip Barber Racing School—which is based in Lakeville, Connecticut, but conducts classes at racetracks all over the country—added some science to the art of race-driver in-

struction. The school's instructors are using a sophisticated computer system to analyze what a driver is doing in the car, then pinpoint the exact things he must do to improve lap times.

The Skip Barber Racing School Monitor is an outgrowth of a system designed by Chris Wallach for use by professional racing teams that build and develop their own cars. Wallach's Marblehead Racing Group Performance Monitor, with its 32 input channels and accompanying software, has been purchased by the likes of Jaguar's Group 44 and Al Holbert's Porsche IMSA GTP teams, as well as Roger Penske's Indy car team.

With the proper transducers installed, the MRG

computer can measure everything from the air pressure at different points on the car's bodywork to the ride height of the chassis at 200 mph.

The Barber system uses only four channels, which record 20 times per second, picking up plenty of information on what the driver is doing. Two of the channels are fed by a pair of acceleration-measuring transducers mounted on the floor of the car. A lateral accelerometer measures sideways g-loading and a longitudinal one picks up front-to-rear acceleration. Together, they paint a computerized picture of the car's performance in the corner.

A DC voltage generator on the tach cable senses engine and vehicle speed, while a magnetic pickup fitted to the car's nose marks its passage over magnetic strips that divide the racetrack into sections.

The \$6,000 or so bits of data from a 15-minute test session are stored in a data recorder, in the cramped cockpit of the Barber BRI Formula Ford. At the end of a run, the data are transferred to a Panasonic Executive Partner portable computer for analysis by the MRG software package.

The software program is really the heart of the system. Wallach spent three years writing and perfecting the software. It picks out the fastest lap and then analyzes



Various pickups feed information on cornering, acceleration, engine and car speed to big black box, then to computer.



Instructor checks printout to show student where he could go faster on the racetrack.

it, graphing engine speed and lateral acceleration.

According to Barber, a 2-time SCCA National Driving Champion and a Formula One veteran, the beauty of the system is in its ability to help students who know the rudiments of racing to learn to go really fast.

"There are people who are driving the right line," notes chief instructor Bruce MacInnes, "and even though they don't seem to be doing anything wrong, they just aren't going fast."

Carl Lopez is in charge of the computer cars, and he starts by having an instructor set a target lap. The students are able to compare their own best lap with that of the instructor.

"They can see, corner by corner, where they are losing time," Lopez says. "They can find the parts of the track where they are losing the most time, and work on those first."

The computer provides detailed analysis of individual corners, so that a student can see if he is perhaps starting his turn too early, or going so fast in the first half of the corner that he is virtually out of control.

It is not unusual during the 2-day Advanced School for a student to take two seconds or more off his lap time. More than once a student has cut a faster lap than the instructor. "At that point the instructor usually wants to get back in the car," says MacInnes.

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Inside Detroit

BY JIM DUNNE



Imperial reborn



Chrysler's front-drive LeBaron GTC will be first with a V6 engine.

Chrysler's Thunderbird fighter, code-named the J-car, looks like a miniature version of the ill-fated Chrysler Imperial of a few years back. The grille has the same vertical theme, while the headlights are covered with body-color caps. However, once past the front the similarities disappear. The lines of this 4-place coupe are softer and sleeker, and gone is the bulkiness of the body of the older model. Big differences lurk un-

derneath the sheetmetal, too. The engine is Chrysler's 2.2-liter Four, with or without turbocharging. The same front-drive system used in most other Chrysler models will show up here, too. Look for this model to be among the first at Chrysler to get the 3-liter Mitsubishi V6.

Official name will be Chrysler LeBaron GTC (hopefully not to be confused with the H-car now called LeBaron GTS, nor the plain old LeBaron).

Plastic Camaro, Firebird

GM is going ahead with plans to build the 1989 Camaro and Firebird the same way as the Fiero. And, say GM insiders, the radical construction technique, which uses a steel undercarriage with plastic outer panels, will probably be widely used on sedans of the future as well.

Advantages are many, and include lighter curb weight, easier assembly at the factory, easier repair of minor body damage and

more frequent changes in body styling. In addition, designers say that the plastic body panels can be bent into shapes that are not possible with steel.

Also, twin cars like Camaro and Firebird can have more distinctive styling—look less alike—without a major increase in tooling costs. That's because the plastic panels can be shaped without the use of high-cost stamping dies.

Chrysler V6

The proposed premium engine for all of Chrysler's front-drive vehicles has the green light for production and will be seen on the streets as early as 1990. The 3.2-liter 60° V6 will be built in the U.S., and replace the 3-liter V6 that Mitsubishi will begin supplying Chrysler later this year. Look for this high-output 3.2 engine to be used for Chrysler's luxury lines first, then added to performance coupes like the Daytona. Expect turbos for musclecars, though that version will come only on later V6 designs.

Adios Avanti?

For a while at least, it looked like Avanti would join the other 6000 or so nameplates in automotive history that have bitten the dust. Latest word is more encouraging. Last March, Avanti was on the auction block in South Bend, where the First Source Bank was selling off its assets—"equipment, machinery and intangibles" (such as its name).

Designed by Raymond Loewy and introduced by Studebaker in 1963, the plastic-bodied and low-volume Avanti has been little more than a curiosity in recent years. It is a one-of-a-kind that never did get the styling changes and technical improvements needed to keep buyer interest strong. It has a revised Studebaker Lark chassis, but its Camaro V8 engine power makes it one of the quickest U.S.-built cars.

If the eventual buyer of Avanti's assets is a liquidator, eager to resell everything for scrap, the car is

history. But if it's a car buff who wants to revive the company, together with the new chassis, body and model designs made by the previous management, one of America's best-known "specialist" makers may yet survive. Several "substantial buyers" in the last category are reportedly in line.

Caddy top chopped

The Cadillac DeVille convertible mentioned in last month's column (page 38) is not a prototype for a 1987 model but a custom car currently available from Car Craft in Lima, Ohio. Cadillac has been testing the conversion at the GM Proving Grounds, but says it has no intention of introducing the car in '87.

New Olds engine

Oldsmobile's 2.3-liter Quad Four engine, due out late this year, is the first completely new powerplant from Olds since the 1949 Rocket V8. And it may be the last, given the way GM is rearranging its engineering groups. Today's plans at GM call for a centralized engine group that will work for Buick, Cadillac and Olds.

For the customers who have seen Olds, Buick, Chevrolet and Pontiac engines go in various GM cars in recent years, this may not seem like a big deal. But to the folks at Olds—those who build the car as well as those who design it—there is a certain loss of pride. They no longer can point to an Oldsmobile and feel it all came out of their shops.

(Please turn to page 40)



Latest Avanti, with body-colored soft bumpers, may be the last.

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Faster turbos coming

A major problem with turbochargers on small engines is lag time. Because the turbo needs time to spin up to pumping speed—100,000 rpm or so—its boost to the engine takes a second or more to come on. If you start out from a stop and floor the gas pedal, the power you feel first is that of a nonboosted engine.

Now Detroit is researching a variable turbocharger, one that will put out a strong boost on demand at any engine speed. The secret is variable vanes at the points where exhaust gas enters the turbine housing. When full power is called for, the variable vanes squeeze the exhaust gases through a smaller opening, thus increasing their pressure. At the same time, the vanes direct the gas flow to the parts of the turbine where they exert the most leverage.

The results are impressive: Overall, GM researchers found that the turbo lag time could be cut an average of 30 percent.

When the car is moving at cruising speeds, the variable vanes open up, allowing the engine to run at its most

efficient, nonturbo, setting. Another advantage of variable-vane turbos is the elimination of the wastegate.

Expect intense development of the variable turbocharger in the coming months, with a finished system ready for new cars in the 1988 model year.

You can also look for compound turbochargers to make big noise. The idea is to have a second turbocharger fitted into the exhaust stream, this one to help run either the engine accessories—like water pump or generator—or the valve train directly. A large reduction gear in the 30:1 range would reduce the 50,000 rpm of this turbo. The connection to the engine parts would be made through a fluid coupling, so that the turbo power would assist the engine, not run the parts by itself. The idea is a reality on heavy-duty trucks now, and looks like something that the auto companies will be developing for cars of the early 1990s. Benefits are said to be a 5-percent improvement in fuel economy, or a similar rise in horsepower.

Electronic shifting

GM is switching over to electronic control of its automatic transmissions as quickly as it can, but don't look for the simpler, more precise units until late 1987 at the soonest. Electronics will be

installed in mid- and compact-size sedans and small trucks first, then spread to other GM models.

Gear shifting will be tied in with engine speed and driver demand more precisely with the electronic controls so that shifts can be made more quickly and more appropriately for the driving conditions.

Look familiar?

No nameplates identify this Mitsubishi compact truck. That's because it is a 1987 prototype that is undergoing cold-weather testing in the northern U.S. The new model looks like other Japanese imports, with styling aimed toward the macho image buyer. It will be sold for the first time as a Mitsubishi Mighty Max Sport, but a similar model will be sold by Dodge as the D50. **FM**



New mini pickup will be sold as a Dodge D50 and a Mitsubishi Mighty Max in 1987.

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Aviation



New chopper for oceans



Mariner from Robinson is designed for duty along coasts.

Robinson Helicopters of Torrance, California, pioneered a new era in low-cost rotorcraft seven years ago with the introduction of its diminutive R22 personal helicopter. Since then, over 500 have been produced with prices and operating costs of less than half that of the piston-powered competition.

President Frank Robinson originally designed the R22 to be an inexpensive personal helicopter, but instead it became the best seller for rotary-winged flight schools.

The newest eggbeater in the Robinson flock is nicknamed the Mariner. This aircraft was designed to accommodate the needs of fishing-boat operators, commercial operators near aquatic environments and well-heeled sportsmen.

The aircraft was heavily modified in order to eliminate many of the common problems associated with the addition of flotation gear, including a raised tail boom.

Wooden P-51

A recent issue of Trade-A-Plane offered a restored P-51 Mustang for the bargain price of \$350,000. If you're looking for an economy version, help is on the way.

Loehle Aviation of Wartrace, Tennessee, recently designed, built, tested and flew a wooden replica of the P-51. Powered by a 50-horse, 2-stroke Rotex 503

engine, this pint-sized P-51 is currently cruising at speeds estimated to be 75 to 80 mph, with a top speed just a shade over 100 mph.

The Loehle "5151" (in honor of its kit price of \$5151) will sport a fixed landing gear for simplicity and ease of construction, and designer Mike Loehle promises that this mini-warrior will be a much easier bird to fly.

Does compute

The computer revolution has been making some significant inroads with the commercial aviation world recently, but a full-fledged aviation/meteorological flight planning database is now available to just about anyone with a home computer. Aviotex/TABS of Costa Mesa, California, is a colorful videotex-based computer offering real-time weather reports direct from the National Weather Service, automated flight planning, the latest aviation news, help with hotel and car reservations, aviation yellow pages and a wealth of other aviation-related services.

Pilot by degrees

Some of the experts who are keeping an eye on aviation statistics indicate that the U.S. is actually running short of licensed commercial pilots. Several aviation colleges are moving to fill the gap. Daniel Webster College of Nashua, New Hampshire, is one of the most innovative institutions. They have a wide variety of aircraft (including motorgliders and aerobatic aircraft) and the most comprehensive training systems. As such, they were chosen by People Express airlines to participate in their recently announced college hiring program. It may start a trend.

Daring voyagers

Just when there seemed to be little left for the record-setters of sport aviation to accomplish, there comes a novel and somewhat intriguing new project. Dubbed

"Fly America" by several adventure-hungry hang-glider pilots, this new enterprise calls for them to attempt a series of interconnected flights that will take them all the way across the United States. Using a variety of means, project organizer Greg DeWolf hopes to lead the first transcontinental, unpowered hang-glider contingent across the many hundred miles of terrain that comprises the good old U.S.A. later this year.

Lightweight radial

Sport aviation enthusiasts have been decrying the lack of a really dependable and affordable lightweight 4-stroke engine for many years. Now, their long wait may finally be over.

A Washington state firm is already producing (and flying) the first of a new generation of light aircraft engines for ultralights and amateur-built aircraft. The Dragon Engine Co. is offering a 50-hp, 6-cylinder, 2-tiered, staggered, 4-stroke radial engine reminiscent of the radial powerplants of old. The nostalgic appearance of the 78-pound Dragon carries a fairly reasonable price tag of \$2495 (including carburetor and exhaust system) for 50 thrusty ponies.

A diameter of 20.5 in. and a length of only 17.25 in. makes for a compact but powerful package that should allow for a great deal of versatility in installing or retrofitting the Dragon on your favorite ultralight or homebuilt. —Jim Campbell



Loehle's "5151" is a Mustang every pilot can afford to fly.

Old House Restoration



BY BOB VILA

Window selection and placement

Fenestration—the design of windows and their placement on the walls and roof of a building—has been practiced by homeowners for thousands of years. Since the birth of architecture, we've been hard at work trying to discover how windows may best serve our needs. Today, this pursuit is busier than ever before, as we struggle to reconcile our longing for aesthetic window design with the need for state-of-the-art, energy-saving technology.

Until the middle of the 19th century, the glass for windows was still hand-blown, and, because of this, it was available only in small panes.

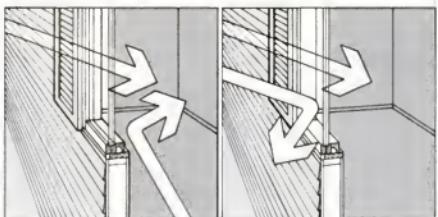
But in the 1850s, improved glass-making machinery permitted the production of larger, more transparent sheets of window glass. The payoff for homeowners was more light

and unobstructed views. In mid-20th century America, single-pane picture windows became the rage. Of course, everyone knew that these large windows weren't very good at conserving energy, but at that time no one really minded.

Then came the 1970s and the beginning of the energy crisis. Suddenly, homeowners were burdened with inflated fuel bills, and they were realizing that windows which were poorly designed, poorly constructed and poorly placed were costing them a lot of money.

There weren't many good solutions until a new generation of energy-efficient windows was manufactured for residential use.

What do these windows do—and where should they be placed for maximum efficiency? Let's examine several types of modern windows and the advantages of each.



Low-E and Heat Mirror windows both have a thin metallic coating that blocks heat. In the winter (left), these windows let in the sunlight but also prevent inside heat from leaving. In the summer (right), they block the heat coming from outside.

Double-pane insulated windows

Although double-pane insulated windows have been in widespread use in homes since the mid-1950s, many homeowners have failed to take advantage of them. Double-pane (double-glazed) units are constructed for more efficiency than single-pane windows: Two sheets of glass—separated by an air space—are hermetically sealed into a tightly bonded, single window unit. The air space between the glass provides insulation from outside air, preventing heated or air-conditioned air from escaping the home. This unit's U-value (a measure of heat flow through a material) is .52, compared to a 1.1 rating for a single-pane window.

This means double-glazed windows lose about half as much heat as single-glass units. Plus, double-glazed units greatly reduce the likelihood of condensation, or "sweating," on their interiors.

Triple-pane windows are simply a further refinement of the same idea. These new models boast U-values ranging from .34 to .39, representing a heat-retention advantage of 25 to 35 percent over double glazing. However, they do have one main drawback: They're heavy and, because of this, they're more difficult and sometimes more expensive to install.

Low-E windows

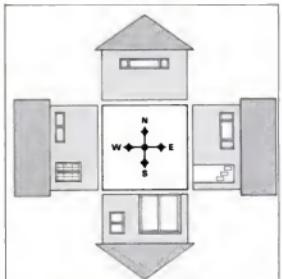
These windows have a new glazing, called Low-E or Low Emissivity. They look like an ordinary double-pane window, but there's one key difference: The inside face of

Contributing Editor Bob Vila is host of public television's "This Old House," funded by Owens-Corning Fiberglas.

the outer pane has a microscopic metallic layer that reflects radiant heat, while allowing the visible portion of the solar spectrum to pass through. In other words, this glass allows nearly all of the sun's visible light to enter the room, while reflecting back into the room most of the escaping heat in the winter.

In the summer, the window rejects most of the invading heat from outside.

Low-E window glass has a



Sample window plan for cold and moderate climates calls for largest windows to face south with less glass on the west and east and the least facing the north.

U-value of .32, losing 42 percent less heat than a standard double-pane unit. And it's even better than a triple-glazed window because it weighs less, costs about the same and saves as much or more energy.

For very warm climates, Low-E glazing is available with a tinted outer pane, which further increases the amount of heat the window keeps out during hot weather. This glazing, which is known as High Performance Sun insulating glass, is also effective in filtering out much of the sun's ultraviolet rays, helping to control the fading of drapes, carpet and furniture.

For even lower U-values, you should look to Heat Mirror glazing. These windows are based on the same principle as the Low-E window, but in this case the metallic coating is deposited on a clear plastic film, which is then suspended between two

panes of glass. You end up with a U-value of only .24.

Keep in mind when shopping for replacement windows that the glazing isn't the whole story. Don't forget to consider the type of material used in the window frame.

Today's windows are made with wood, vinyl and aluminum. Some manufacturers make wood frames clad in aluminum or vinyl. These models offer the double advantage of traditional wood on the interior of the home, along with easy-to-maintain vinyl or aluminum cladding on the outside.

Window placement

Once you've determined the type of window that best suits your needs, the next step is to decide where the window should be placed. This may not be an easy task, as you may have several objectives to satisfy at the same time. Let's examine them one by one.

Conserving energy—In all except the warmest climates, large window openings should be placed on the southeast, south and southwest sides, according to the internal requirements of each space. This will allow for the greatest possible passive solar gain.

East and west windows should be moderate in size. Northern windows should be kept small, and if possible, equipped with Low-E glass. This way, you'll be able to take full advantage of solar heat gain during the winter while providing indoor comfort and energy efficiency all year round.

In very hot climates, where air-conditioning costs are the prime concern, the largest window area should face north, with lesser amounts to the east, west and south. This will reduce heat gain during the summer.

Improving view—Picture windows, with their fixed, large glass sections, will provide you with a panoramic view of your surroundings. But they also can spoil your privacy as well as provide an easy route for heat to escape. So if you live in a cool or moderate climate and decide to install a picture window, use Low-E or Heat Mirror glass, especially if the window faces a direction other than south. Larger windows facing the street are best placed higher on the wall. This helps maintain privacy while still affording a view.

Optimizing sunlight—One of the best ways to increase the amount of light your home receives, without compromising your privacy, is with a skylight. Again, a southern exposure will be most efficient. Of course, the heat loss through an uncovered skylight will be greater than through an insulated roof, but this loss can be cut down to acceptable levels by using Low-E or Heat Mirror glass.

As for wall windows, a larger one will

provide more light than several smaller ones. For an even distribution of light, use windows in more than one wall wherever possible. Tall, narrow windows placed high in the wall allow for the deepest penetration of light, while short, wide windows provide a broad, shallow light.

Improving ventilation—To maximize ventilation, some windows should face directly into the prevailing wind with others placed on the opposite side of the house. Large windows, representing at least 10 percent of the floor area in each room, will give optimum results. The greater the height differ-

ence between the inlets and outlets, the greater the flow of air will be.

So, owners of older houses, take heart: Though the builder of your home probably never had the desire or the resources to maximize the efficiency of your windows, the consequences can probably be undone. All it takes is a careful assessment of your fenestration needs, a little homework and a plan of action. With moderate effort and reasonable expense, you should be able to make a big improvement on your existing window system, thereby reducing your energy costs and making your home more comfortable. **FM**

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Tool Tests



Staple gun fastener

Expand the versatility of your staple gun with this unique accessory from Arrow Fastener, 271 Mayhill St., Saddle Brook, NJ 07662. The fastening attachment converts Arrow staple gun models T-50, T-50M and T-55 to shoot Xpando fasteners. Use these tight-gripping, expanding fasteners in wood, a bracket is secured to metal tubing.

The $\frac{1}{8}$ -in.-dia. fasteners range in length from $\frac{1}{8}$ to $\frac{3}{8}$ in. First, bore a $\frac{1}{8}$ -in.-dia.



Snaps-on accessory allows driving expanding fasteners quickly with a staple gun. Here, a bracket is secured to metal tubing.

pilot hole to the required depth and insert the fastener. Next, snap the attachment onto the head of the staple gun, position it over the fastener's pin and push down on the handle. This will drive the pin which, in turn, expands the fastener, causing it to grip firmly.

The attachment is about \$4.50. Fasteners range in price from \$1.25 for four $\frac{1}{8}$ -in.-long fasteners to \$2.25 for eleven $\frac{1}{8}$ -in. fasteners.

—Rosario Capotosto



Attachment fits three different Arrow staple gun models. Rivet-like fasteners come in five sizes.



Fasteners anchor securely to brick. If pin doesn't drive flush, reposition, and shoot again.



Close-up shows how driven fastener (upper) expands. Lower fastener is ready to be shot.



Can of filler comes with a small tube of hardener. Mix only enough filler for the job at hand. Filler won't harden in the can.

Filling a niche

Minwax has introduced a product called High Performance Wood Filler (HPWF) that it claims will outperform any other filler on the market. I tested HPWF to see how it compares to the other fillers I've tried. The testing was simple, but practical. I wanted to know how well HPWF adhered to wood, how well it would form a sharp corner, and how would the filler stand up when exposed to moisture and heat.

I applied filler to a deeply gouged corner of a wood turning. After only 20 minutes, I struck the filled corner several times with a hammer's handle. Since HPWF dries tough and resilient, not brittle, the blows caused no damage. Then, I filed and sanded the filler flush with the surface to form a sharp corner. I found that HPWF tools nicely.

I filled a gouged end in a 2x6, waited 30 minutes and then placed the filled end in boiling water. The 2x6 was left submerged for two weeks. During this time, the filled area was removed from the water, blasted with a hot air gun and returned to the water. This was repeated six times, but the filler showed no ill effects.

Look for HPWF in 6-ounce (\$5.49) and 12-ounce (\$7.99) sizes at home centers. Contact Minwax, 102 Chestnut Ridge Plaza, Dept. RK, Montvale, NJ 07645.

—Rosario Capotosto.



1 The inverted lid serves as a mixing tray. Add hardener from the tube and mix thoroughly.



2 Apply filler to the damaged area with a putty knife. Filler hardens in 15 to 20 minutes.



3 Use a file to remove most of the excess filler. Then, sand the filler flush with the wood.



4 Completed patch is smooth and solid. But note that filler doesn't accept stain very well.



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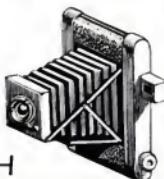
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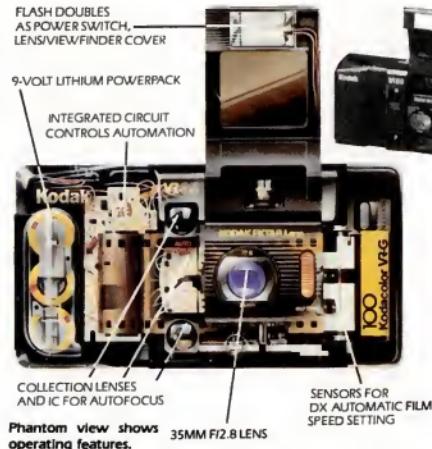


BY STEPHEN A. BOOTH

Father Yellow sires 35

The point-and-shoot auto-focus camera was still a gleam in an engineer's eyes when Kodak stopped making 35-mm cameras. Now, the auto-everything compact outsells its single-lens reflex cousin, and Kodak's back gunning for a piece of the action with its first 35-mm cameras in 15 years. After putting one model through its paces, I've concluded it's been worth the wait.

Father Yellow's engineers really did their homework in designing the VR35 models K10 (\$130), K12 (\$200) and Medalist (\$222). All three boast infrared automatic focusing, automatic exposure setting, and automatic flash that fires when it's needed. That flash system is the key to the VR 35 series' uniqueness.



PM Photo Album—Tips For Better Pictures

Night photography is a world made of artificial colors. Each type of light source (tungsten, neon, fluorescent or vapor lamp) is perceived differently by daylight-balanced films. You'll need a tripod (or any steady surface), cable release and camera with adjustable shutter speeds. Most metering systems will give up at the lack of reflected light. If the scene contains a well-lit area, such as the sidewalk under a marquee, meter manually off of that. If not, then try this: With ASA 400 film, shoot some pictures at $\frac{1}{2}$ sec., $\frac{1}{4}$ sec., $\frac{1}{8}$ sec., and $\frac{1}{30}$ sec., $\frac{1}{4}$.

If you have an autofocus compact, you can trick it into altering its exposure by changing the film's ASA (ISO) value. Use a fast film (ISO 1000) and take a series of shots starting at ISO 25, doubling the ISO number between each shot. One of these should yield acceptable results. Color slide film works best. The examples below show how the correct exposure depends on what and how much you want to show.—Armand Ensanian



As you'll see in the accompanying illustration, the flash unit flips up and away from the camera body. When closed, it acts as a cover for the lens and viewfinder, and as the power shutoff for the camera. Open it and you turn the camera on—but there's more to it yet.

Positioned well above the lens, the flip-up flash mini-



New VR-G film renders punchier colors.

mizes incidents of red-eye. This picture-marring defect occurs when a flash, located too close to the lens, reflects in your subject's retina. Placing the flash directly above the lens has another benefit: It minimizes side shadows caused by side-mounted illumination.

Besides firing automatically when needed, a switch on the camera lets you use the flash to fill in shadows caused by side- or backlighting conditions. Moreover, in the flash mode, Kodak's automated exposure system keeps the shutter open to admit more ambient light. This means your pictures won't have those dark, contrasty backgrounds and washed-out highlights, which so often make flash pictures seem unnatural. The flash recycles in less than two seconds on the K12, thanks to the camera's 9-volt lithium battery. Kodak says this powerplant should get you through more than 2300 exposures. In a pinch, you can use a more readily available 9-volt alkaline battery for power.

The K10, K12 and Medalist share other features. These include automatic loading and DX film-speed setting for ASA 100, 200, 400 and 1000 films. The K12 uses an extremely sharp 35-mm f/2.8 aspheric glass lens that focuses to within 3 feet. The K10's 35-mm f/3.5 will get you within 4 feet. Shutter speeds range from 1/30 to 1/500 of a second on the K10 and from 1/45 to 1/500 on the K12. Film advance and rewind are automatic in the

(Please turn to page 51)

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PHOTOGRAPHY

(Continued from page 49)

K12, manual in the K10. The Medalist model adds a data back to the K12's appointments.

With so much going for them, I can only criticize the VR35 series cameras for what they're *not*. Father Yellow might have enhanced the camera's usefulness by building in a dual-lens system, for normal and telephoto shooting. This is a popular feature on the latest autofocus compacts. Indeed, some Kodak Disc cameras offer this option!

Meanwhile, to complement its nifty new 35-mm snapshotters, Kodak has introduced two improved 35-mm print films designed to make picture-taking a little more foolproof.

The new films carry the VR-G designation and come in ASA 100 and 400 speeds. Compared to the VR print film they replace, the new formulations will give you punchier, more saturated colors and more sharply defined outlines around your subjects. The new films also have wider exposure latitude: Colors will remain consistent under different (and difficult) lighting situations. In fact, you'll see consistent color even if the picture's underexposed by one stop or overexposed by two. (According to Kodak, about half of all amateur photos are underexposed, often from flash misuse.)

I've checked out the color and exposure latitude claims and found the new films do exactly as promised.

In photographs of the same subject shot under identical lighting, VR-G did give punchier color and sharper edge definition than the discontinued VR.

Then, using the auto-exposure program mode of Canon's new T90 (see *Photography*, page 61, April '86) as our exposure reference, I deliberately under- and overexposed the VR-G 100 and 400 films. The results were perfect within Kodak's 1-under/2-over range and—surprise—even acceptable well beyond Kodak's claims. No special processing was involved. I believe in real-world testing, so I sent the films to a regular, walk-in 1-hour lab, just as you'd probably do.

You won't see my pictures here, but Kodak's photo of a catamaran (shot on VR-G 100 with a K12) demonstrates the quality you can expect from the new film and camera. That picture, by the way, has been magnified 400 times to make a 30 by 50-foot display now gracing the exterior of New York's Marriott Marquis Hotel.

Instant gratification

You'll have to wait for the details, but by the time you read this, Polaroid will have introduced a third-generation instant print system which the company

claims will rival 35-mm print quality.

The hush-hush product is code-named System 7000. Based on hints from Polaroid and some deducing of my own, the new instant print system relies heavily on electronics and accessories to deliver the imaging quality and flexibility that Polaroid promises.

By my guesstimation, the print size is larger than current Polaroids. And you'll be able to get *copies* and *enlargements* of your instant prints.

The way I dope it out, Polaroid's come up with a laser-scanning device that will read the original, digitize the image then reproduce it. If this can be done, then it's possible, too, that out-of-focus and incorrectly exposed photos can be electronically enhanced to produce acceptable images.

You can take autofocusing for granted, and there will likely be a slew of accessory lenses and filters to give you lots of versatility, special effects and creative control over your pictures. Price? Probably about the same as a 35-mm auto-everything compact. Tune in to future columns to check my slugging average on this training camp report.

Improve your grip

There's still time to get yourself a free \$90 Power Grip for the Ricoh XR-P or KR-30SP if you purchase either of the 35-mm SLR cameras before July 1.

The Japanese camera maker is celebrating its 50th anniversary—whence the generosity.

A power grip's a great add-on for any camera. For one thing, it makes it a lot easier to hold the body and trip the shutter without unnecessary vibration. That's because the grip is molded to fit your hand, and the shutter release is angled for comfortable operation. Addi-



Power Grip for Ricoh SLRs attaches to tripod socket, advances film and aids handling.

tionally, the "power" part of the grip gives you a 1 1/4-frames-per-second transport for automatic and continuous film advance. Unlike built-in power winders; battery failure in the grip doesn't disable the camera. You revert to manual operation via the film advance handle.

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Home Video



BY JAMES B. MEIGS

Get set for digital

Digital TV, with its ability to freeze pictures and show two channels at once, is finally creeping closer.

For some time, only TV-innovator Toshiba offered a digital model, but now several additional manufacturers have unveiled plans for chip-based sets. There's even a set-top device you can hook up to your present TV to get digital effects.

When true digital TV arrives, it will do more than freeze a grand-slam swing or let you follow two bowl games at once. You'll also be able to zoom in on a scene you freeze. You'll keep your set longer, too, since the TV's microprocessor will perform self-diagnoses and adjust itself to maintain perfect performance as the set ages. City dwellers haunted by multipath will be happy to know that digital processing will banish ghosts.

It takes a complex (and costly) microprocessor circuit to perform all these wonders. That's why current digital TVs (such as Toshiba's) perform only one or two tricks. Until now, even these limited chips were available

only from a West German division of ITT. Happily, other electronics manufacturers have circuits of their own under development.

In the meantime, you can enjoy some digital effects in the model CZ-2094 from Toshiba. There's also Sony's new 27-in. Trinitron and NEC's 26-in. DT-2680A.

Sony's \$1700 Trinitron has two tuners built in, so you needn't use your VCR's tuner to put the PIP (picture in picture) on your screen, as you must with the new NEC and older Toshiba. NEC's set (no price announced) lets you freeze up to three images and display them simultaneously.

If you've got a perfectly good TV but want to add PIP effects, the MultiVision 3.1 is for you. The \$400 device sits atop your TV, tunes in a second program and sends it to your screen along with the main program. Its wireless remote lets you change the size and location of the PIP. You can freeze action on the smaller image, or scan other channels while watching a program on the main screen. It gives stereo sound, too.

Cable TV blues

I had just advised a friend on what kind of stereo TV and VCR to buy when he asked me, "Will I be able to get stereo from my cable company?" Good question.

Even though stereo television broadcasting (or MTS—multichannel television sound) is sweeping the country, millions of paying cable subscribers can't be sure their cable companies will pass along the stereo signals that over-the-air viewers pick up for free. For those whose cable companies can't pass along MTS signals, buying a fancy stereo TV or

of the more common RF (radio frequency) type. While RF converters keep the audio and video signals combined in the RF form in which they are broadcast, today's baseband converters separate the audio from the video—eliminating the MTS signal in the process. Fortunately, baseband converters that can handle MTS are on the way. Many cable companies will supply them free of charge to customers who ask for them.

It's important not to confuse cable operators that pass along MTS signals with those that use the older FM simulcast method. This



Sony's 27-in. Trinitron and NEC's DT-2680A [right] let you watch two shows at once.



MultiVision 3.1 adds digital effects to regular TV sets

VCR would be a waste of money.

Fortunately, 44 of the top 50 cable companies are now passing MTS signals to at least some of their subscribers. Most of those that aren't providing stereo today plan to do so eventually. In fact, since the stereo signal broadcast by TV stations is buried inside a normal mono signal, many cable systems can pass it along without any equipment changes.

Some cable subscribers might not be able to get MTS for a while. About 20 percent of cable systems provide their subscribers with a set-top converter known as a baseband converter, instead

method requires a special hookup from your cable box to your FM stereo tuner or receiver and speakers.

To make things more confusing, some cable systems use FM signals to carry stereo soundtracks of certain channels that are available only on cable (such as MTV and HBO), but also pass along stereo from stations broadcasting MTS.

Let's hope cable companies will get smart and convert *all* their stereo channels to MTS. In the meantime, better check your cable company to see if it can handle MTS before you buy an MTS television or VCR.

(Please turn to page 54)

NEXT MONTH, SEE HOW THE FUTURE OF AMERICA IS BEING BUILT. PAGE BY PAGE.



For generations, Popular Mechanics has inspired Americans to turn their skills and their self-reliance into building a better life for their families, their communities, their country.

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Want to apply silicone sealant like a professional? Use a soapy old spoon!



Over time, ordinary caulk cracks and falls apart. When that happens, it's time to remove the old caulk with a screw driver and replace it with a durable seal.



DAP® DOW CORNING® General Purpose Silicone Sealant is the perfect solution. It's so flexible, it adjusts to movement and weather changes. Just squeeze it into place.



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Depend on DAP

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HOME VIDEO

(Continued from page 52)



Cleaner from Advanced Video Dynamics dispenses liquid, scrubs heads automatically.

Head games

Are VCR head cleaners safe? It depends on who you ask.

Many VCR makers say only a qualified service center should clean your video heads. But some salespeople swear that a head-cleaning cassette is something you need.

The truth lies somewhere in the middle. Video heads do get dirty, and professional cleaning costs a fortune. The head-cleaning cassettes available from well-known companies are quite safe for VCRs, if they're used properly.

The dry-type head cleaner works by wearing down the crud that accumulates on video heads. Leave it in for too long and it'll start wearing down your heads as well. Never let the cassette run in your VCR for longer than the recommended amount of time—generally just a few seconds.

Wet-type cleaners, which use a solvent such as freon to dissolve head grime, can't possibly wear down your heads. But you don't want large quantities of strong solvents spraying around inside your VCR, so caution is advised.

The most foolproof wet head cleaner I've found is from Advanced Video Dynamics. You simply insert this battery-operated cassette in your VCR and press PLAY. It automatically dispenses just the right amount of cleaning fluid on the cleaning tape, runs for a few seconds, then beeps to tell you it's done. No mess, no mistakes.



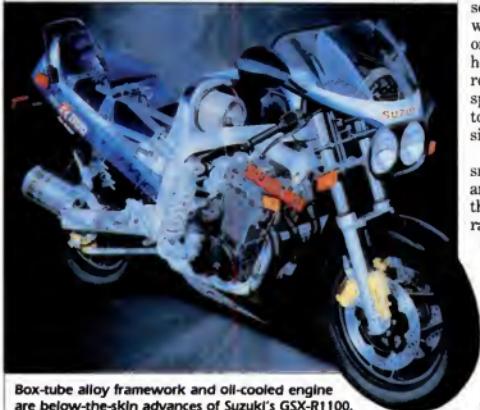
Discwasher's Video Head Cleaner uses dry system to remove accumulated debris.

Cycles

BY NORMAN MAYERSON



Technology warrior



Box-tube alloy framework and oil-cooled engine are below-the-skin advances of Suzuki's GSX-R1100.

Mark 1986 on your calendar as the year that the "less-is-more" philosophy came to the world of leading-edge motorcycles. With the introduction of the GSX-R1100, Suzuki has moved back up to the top level of replica racer bikes by offering buyers less than ever—notably, less weight in the chassis and less complexity in the engine.

While that may not sound exactly like breakthrough technology, look at it this way: At 505 pounds with a full tank of gas, the GSX-R is a clear 80 pounds slimmer than anything else in the class. That's about the equivalent of taking 400 pounds off a 3000-pound Corvette. The diet program is more than a little weight-cutting here and there. Real-

ly, it's major rethinking of chassis construction, right down to the framework.

The 28-pound frame is fashioned from rectangular aluminum tubing using a multirib cross-sectional design. It is distinguished by a built-up ridge at each corner and an exclusive MR787 alloy that has a distinctly brilliant sheen. All told, it's about half the weight of what a steel framework would come in at.

The GSX-R1100 16-valve Four pump out 130 hp, and that sort of output normally dictates a water-cooling system to keep meltdown from occurring. The Suzuki engineers, however, developed the simplified Suzuki Advanced Cooling System. Instead of adding a boatload of intricate passages and fail-

ure-prone sealing devices, they doubled up the cooling job and assigned the oil to the engine's lubricating oil.

First they designed the engine with deep cooling fins and upped the sump capacity to 5.3 quarts. Then they added a second pressure pump and hung on an 8000-kilocalories-per-hour aluminum radiator. But the real job of getting the oil to the hot spots is given to a series of directed oil jets, which spray coolant directly on the head surface over the hot combustion chamber roofs; crankcase-mounted sprayers shoot oil at the piston crowns from the underside.

The GSX-R1100 and its smaller GSX-R750 sibling are more racetrack-oriented than the competing road-race clones. But the Suzukis are far ahead in absolute technological terms. Take the front suspension, for example. Antidive systems are required admission in this class of canyon fighters, but most are ineffective in damping front-end compression under hard braking or give a mushy brake-lever feel due to their plumbing arrangements. Not the GSX-R, though—the antidive is electrically activated by a switch on the front brake lever.

Those front brakes are mighty impressive. A total of eight opposed pistons pinch the 12.2-in.-dia. rotors. The discs themselves are a full-floating design, mounted to the front hub on pins that allow them to move freely within small limits. This way, they are allowed to expand under severe braking without warpage.



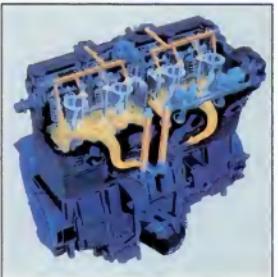
New leader of the roadrace-replica class is the track-ready 130-hp GSX-R1100.

Suffering from technoshock yet? If not, try this—the Suzuki carries the latest in rising-rate rear suspension geometry, as you would expect, but the efficiency has been upped with the addition of a remote reservoir for the shock absorber oil to prevent overheating. Eighteen-inch die-cast alloy wheels at both ends mount V-shaped radial tires, old technology by car standards but fresh from the racetrack in the 2-wheeler world.

All of this would not be such big news if the GSX-R1100 was priced up in the stratosphere, but at \$4999 (as of this writing) it sets new records in performance per dollar. Calculated top speed works out to better than 160 mph, and quarter-mile times with that fantastic power-to-weight ratio ought to be solidly in the low 10-second range.

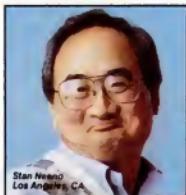
Ten years ago you couldn't have bought this kind of performance for any amount of cash; in 1986 you can get it in streetable form at your local dealership.

(Please turn to page 56)



Cooling is by oil jets directed at cylinder head hot spots and piston undersides.

Dupli-Color turned Stan into an auto touch-up expert



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K&N® PERFORMANCE NEWS

K&N's Filtercharger® Your RV Will Breathe a Sigh of Relief

A simple "over the river and through the woods" doesn't always get your RV where you want it to go. In the real world your RV has to endure everything from the thin air of the mountains to the dust of an off-pavement trip to a secret campsite. Even under the dirtiest conditions, a K&N Filtercharger will help your RV run better by letting it "breathe" easier.

Our air filter flows almost twice as much air as the best paper filters. And because it's constructed of oiled cotton-gauze layered between screens, a Filtercharger will keep flowing long after ordinary filters clog and strangle your RV's powerplant.



Millions of tiny oil-coated cotton fibers strain incoming air to remove even the smallest impurities. As a result, your RV performs better and lasts longer. And once you buy a K&N Filtercharger, you'll never buy another air filter. A quick wash and re-oiling, every 50,000 miles or so, are all you need to put a dirty

Filtercharger back on the road. Get a K&N Filtercharger for your RV. You'll both breathe easier.

K&N products are available by direct mail. RV filter shown is p/n E-1530 and fits most Dodge engines. Send \$27.58 plus \$5.00 shipping and handling to K&N Engineering Inc., P.O. Box 1329, Riverside, CA 92502. Complete catalog \$3.00.

CYCLES

(Continued from page 55)



Tune-tote adds speakers to your personal stereo for on-the-road entertainment.

Showtime goodies

Lurking between the composite carbon fiber framesets and the designer riding wear at the Bicycle Dealers Showcase Expo were a number of practical accessories that caught our eye.

Tuning in to your favorite music through headphones is certainly dangerous where you live. The Tune-Tote solves that problem by mounting two stereo speakers and your personal portable radio or cassette unit to give you mobile music. Tune-Tote comes with weather-resistant speakers and sells for \$39.95. For more information, contact Novi, 4480 Camino De La Plaza, Suite F, San Ysidro, CA 92073.

Before the '84 Summer Olympics, you probably never saw full disc wheels on bicycles. Now the racing ranks are full of them (where they are legal for competition) and there's a good reason—superior aerodynamics. Spoked wheels stir up the air with a turbulent eggbeater effect, and the resulting drag is just the same as towing along a few extra pounds. Flat spokes and aero rims help out, but disc-type wheels still offer up to a 30 percent improvement. From Trueline Products comes an all-aluminum disc wheel for the BMX set. The riveted construction makes them super strong, and clear, black, blue, red or gold anodizing gives them a full dress appearance. They run \$130 per pair from Trueline Products, 1517 Downey Rd., Los Angeles, CA 90023. **PM**



Aero disc wheels are track bike spinoffs, now available for BMX berm bashers.

PM TECHNOLOGY UPDATE 6/86



PM ILLUSTRATION BY ED VAILIGURAY

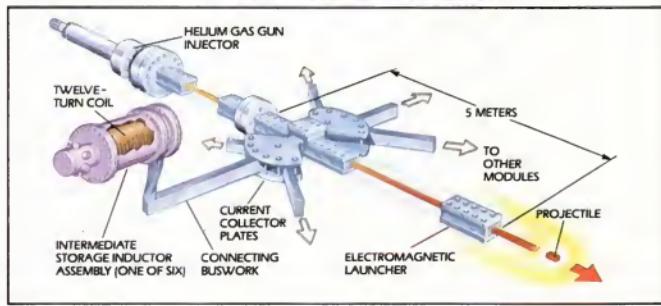
Quick on the draw

Checmate Railgun is an electromagnetic launcher, the latest space cannon for the Star Wars defense arsenal. Floating in low-level orbit, a scout satellite can spot the flash of any attacking missile. Its railgun fires. Stored high-intensity electric power is transferred to the projectile as it leaves the rails, or barrel, of the gun. This charge becomes a hyperboost of kinetic energy, speeding the bullet at over 2 miles per second. Because of this incredible speed, at the target the 3-ounce shot has the impact of a freight train. Any offending missile would

be smashed out of the sky as it began to climb, a minute or two after its launch. Pentagon leaders argue that development and deployment of railguns like Checmate will prevent any surprise enemy missile attacks.



Checmate Railgun (above) zaps enemy spacecraft or can stop a missile as it is launched. Operating model (left) at Maxwell Laboratories in California tests this kinetic energy weapon. Concept (below) is to charge projectile with electrical power as it speeds out of railgun.



Editor: Dennis Eskow
Assistant Editor: Tim Snider
Contributors: Paul Burd, Steve Eskow, Paul Stenquist, Jan Norby, Irena Scott, Chris Mitchell, Michael Filion, Wade Hoyt

TECHNOLOGY UPDATE

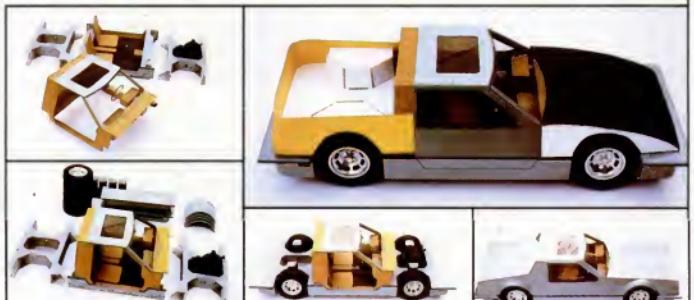
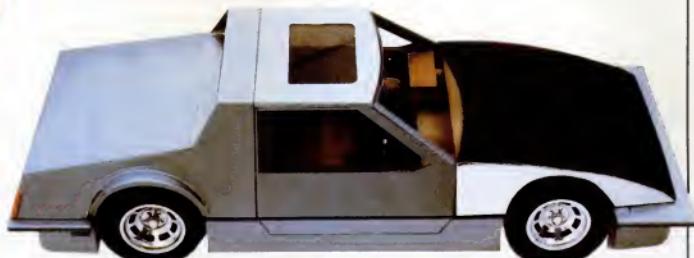
6/86

AUTOMOTIVE

Adaptable featherweight

BRE Automotive Research and Development of Great Neck, New York, has patented a modular chassis automobile that should prove lighter than current designs while adapting to a variety of body styles.

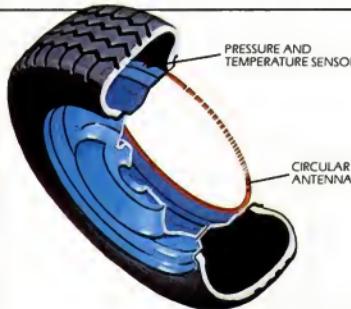
The chassis consists of four separate modules, including front and rear cradles, a floor tray, and a capsule that acts as a truss for the cockpit section. The pre-formed modules can be molded of high-strength composite plastic or other lightweight materials, then joined with conventional fasteners. Suspension parts are attached to the rigid H-shaped cradles and seating is mounted on the floor tray. The engine can be located on the front or rear cradle. Front and rear body sections of precolored synthetics are simply attached to the cradles, allowing for a variety of body styles on one standard modular chassis.



Modular car is based on four molded chassis units to which other components are attached.

Cradles are attached to opposite ends of the floor pan. Passenger capsule serves as a truss.

Various front and rear body sections are easily adapted to one standard modular chassis.



'Talking' tire

An ingenious tire surveillance system from Michelin may be in production soon. Sensors in the tire monitor both pressure and temperature. Data from these probes

are transmitted by a circular antenna attached to the wheel. Processed by an on-board computer, the information will be displayed on the dash. The system will be immune to weather, and works to ensure tire safety.

TRANSPORTATION

Supertrain

This new German prototype could be the train of the future for Northern Europe. It looks like an airliner inside and out, and it can cruise all

day at 180 mph with its 12,000-hp powerplant. Rotor-current drive motors combined with high-performance electronics and computer controls will make this future train super efficient as it flies across the tracks.





Packing a rod

Pumping iron like a spaghetti machine, a new computer-controlled continuous steel casting machine is now in production at the Thomas Steel Corp. The metal is first a liquid, coming from three



ENGINEERING

50-ton arc furnaces (far left). The molten steel is poured into a ladle and transferred into the continuous caster. This machine forms the liquid metal into long, continuous billets, or rods, as shown at left. These billets can be between 4 in. and 6 in. thick, with lengths from 5 ft. to 30 ft. Mill officials say continuous casting produces a higher quality steel because less gas is trapped inside to weaken it as it cools. Standard mills use an older process to produce ingots. These brick-like forms must be reheated and then reworked to make anything. The continuous process directs the hot billets immediately into further manufacturing. Mills like this new one will be more competitive to foreign mills with a better, tougher steel.



Laser print

The laser fingerprint detector (left) makes life much tougher for crooks, and has solved some crimes that had the cops fooled. This portable machine, by Laser Photonics, can be used in the lab or at the scene to locate fingerprints on surfaces, such as concrete, cloth, or vinyl,

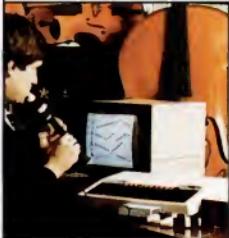
ELECTRONICS

where they might have gone undiscovered. Also, hard-to-see substances like gunpowder or bloodstains are illuminated with this laser light. It can even see through layers of paint to pin the dirt on the real culprit.

This laser can I.D. in minutes what took hours for Dick Tracy's best men.

Trained ear

You could become a Pied Piper with this new music recognition system developed at Cardiff University in Wales. Or you could record a piper's song on your home computer, and the software will print it out with each exact note and staff. The system is a special microphone, an electronic signal processor and a software graphics program. It writes each note as it is played, remembers, and will play back the "music." It could be a music-teacher to help a child or adult learn to play an instrument without schedules, or record original music with a written score.

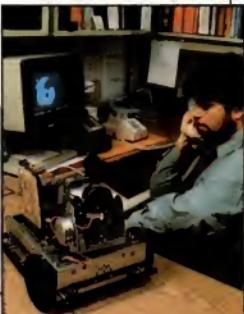


oped at Cardiff University in Wales. Or you could record a piper's song on your home computer, and the software will print it out with each exact note and staff. The system is a special microphone, an electronic signal processor and a software graphics program. It writes each note as it is played, remembers, and will play back the "music." It could be a music-teacher to help a child or adult learn to play an instrument without schedules, or record original music with a written score.

Remote robot

A computer-controlled robot that can be operated by telephone hookup is part of a Multi-Media Remote Teaching System (MRTS) recently developed by AT&T and the Illinois Institute of Technology. This 2-way system also contains a video network allowing input/output of visual images. The camera-equipped robot can recognize basic images and transmit this info digitally over the phone lines to a processing center. A training tool

now, it could be your trusty remote helper.



TECHNOLOGY UPDATE

6/86

INNOVATION

Energy run

The goal of the Shell Marathon, held in England, is to see a vehicle go 1000 miles on a liter of gasoline. Nearly two dozen specially built "cars" are developed for this competition. Many are the class project of university technical departments fired by passionate rivalry. But no matter how high the spirit, the rules are clear. All entries must use up every drop of fuel, and maintain 25 km/hour. The latest technology abounds and onboard computers monitor functions. Shell wants this competition to spark excellence and invention—and ideas for future vehicles.



Wind antenna

This prototype hybrid power station could be the answer for reliable electricity at remote locations. It is hybrid because it combines both wind and solar power with wind turbines and photovoltaic cells. Being tested on the Carolina coast, it powers the master radio system and radar and microwave equipment for military aircraft training programs. The whole system is unattended,



with its data and control system monitored by telecommunications direct linkage to the main base.

MILITARY

Chinook helicopter

Coproduction has produced this "international" helicopter. In a 3-phase program, this Chinook-brand chopper will be built by Kawasaki

from Boeing parts. First, stripped but flying shells will be outfitted in Japan. Then knock-down major sections will be assembled overseas. Finally, Boeing parts will be supplied to a totally Kawasaki-built Chinook. Coproduction brings more business to U.S. aerospace.



Low jumping

A new 3-canopy parachute system can take the worry out of being close. The extra canopies allow the chute to inflate rapidly, and much lower. It has been tested safely at 262 ft., where

troopers are underneath any sentinel radar, and only for about 10 seconds even if detected. The new system is 5 pounds lighter and less bulky than standard GI chutes.

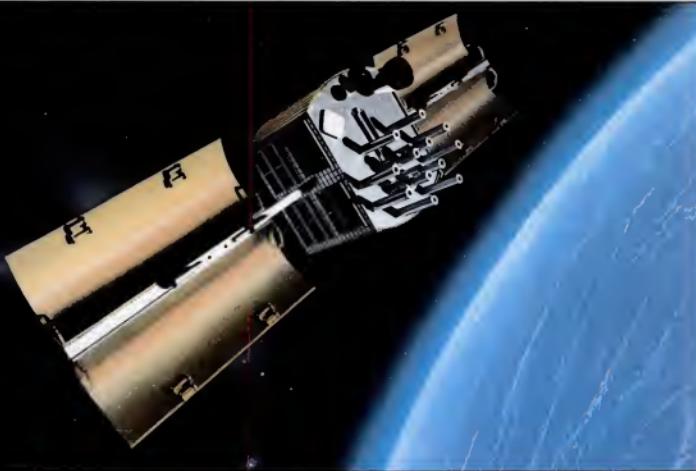


AEROSPACE

Look out below!

New eyes in the sky can now see it all. The Global Positioning System employs a hot new generation of optical sensor developed at Sandia National Laboratories. Continuously watching Earth, its highly sensitive radiometer registers all flashes of light, and translates that data to an electronic brain onboard. This logic unit evaluates intensity, duration and location. If there is a secret nuclear test anywhere, the GPS will tattle. And with 18 planned GPS eyeballs in orbit, it will be no big thing to pinpoint a lost ship or wandering aircraft.

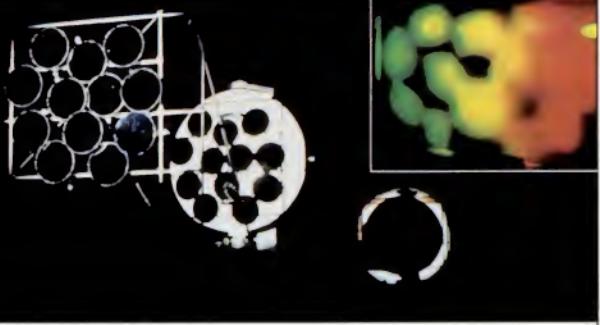
PAUL ILLUSTRATION BY BRIAN SULLIVAN



ASTRONOMY

Mirror, mirror . . .

A high-powered spectrograph machine may tell us more about the sun. Twelve flat mirrors (right) feed unfocused sunlight into the spectrograph. As the light sample (insert) is monitored during sunspots and other solar activity, new data is revealed about the sun's composition, density, gases and other features.



AVIATION

Sky game

It is no secret that video game-like instruments have replaced the silk scarf in fighter planes. But now one device will organize many separate inputs onto one color screen. Your plane is at the center of the screen, with friends as round symbols, unknowns as rectangles and enemies as triangles. This tactical and flight data are transmitted to ground computers for extra coaching and better chances for victory.



Flying economy

Airliners in the 1990s may be powered by unusual motors such as General Electric's Unducted Fan. Engineers expect this motor to provide fuel savings of 40 to 60 per-

cent. Variable-pitch, direct-drive fan blades are driven by counter-rotating turbines. Unlike usual prop engines, the UDF soars with more blades, but they're shorter and wider.



Minicourse



BY ROSARIO CAPOTOSTO

Anchoring to masonry: 2

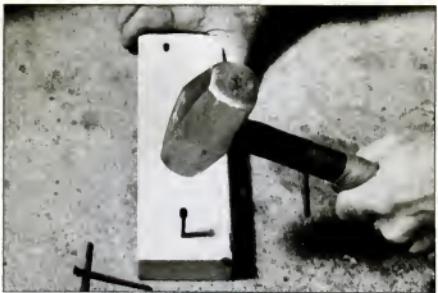
Last month we talked about a variety of masonry fastening devices, some of which were fairly specialized. This month, we'll show their more common siblings, including cut nails, masonry nails, drive pins, screws and toggle bolts.

Cut nails, fluted round nails, twist nails and drive pins are the simplest means of fastening wood to masonry for light-duty jobs. With the exception of drive pins, these wedge-type fasteners are driven like common nails, but with a heavier hammer (about 2 pounds). They are made of hardened steel and thus are more brittle than regular nails. Make sure to wear safety glasses when driving them.

Drive pins are not driven with a hammer. A special tool that prevents them from bending must be used. We show the Molly drive tool by Emhart Home Products, Reading, PA 19605. Insert the pin in the tool's barrel and hammer the driving rod. The pin, under the rod, is driven into the masonry.

Black & Decker's Grip-It screw kit is an alternative to nails or pins when hammering the fastener is impractical. The kit pairs a carbide-tipped drill with self-tapping masonry screws.

Toggle bolts are a good alternative when fastening to concrete blocks as shown. They're strong and easy to install. Bore a hole into the block void with a masonry bit, push bolt's wings through and tighten. **PM**



Cut nails are the simplest type of masonry fastener. Drive them with a heavy hammer, keeping the nailhead parallel to the wood grain. Stop hammering once head is flush or it will loosen.



Hold the Molly upside down and then "load" it by sliding a drive pin into its barrel. The tool holds the pin upright as it's driven.



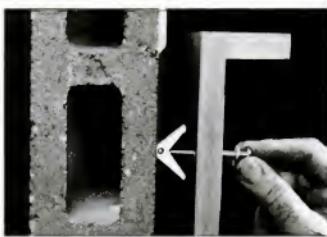
A heavy hammer is used to strike the drive rod. The pin, below it, is driven into the masonry. The top flange protects the user's hand.



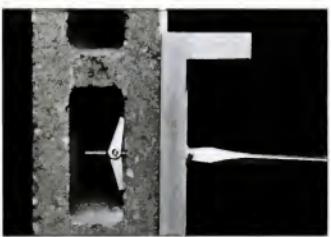
Self-tapping masonry screws are an alternative to cut nails and other wedge fasteners. Use a carbide bit, matched to the screws' size, to bore the hole.



Once their holes have been bored, masonry screws are driven in the same manner as wood screws. They work with concrete, block or brick.



Toggle bolts excel for securing heavy loads to hollow concrete block walls. Their wings, pushed through the hole, expand on the other side.



The toggle bolt threads through a nut in the wings, pulling them against the wall and tightening the wood against the masonry in a vise-like action.

TOYOTA TRUCKS



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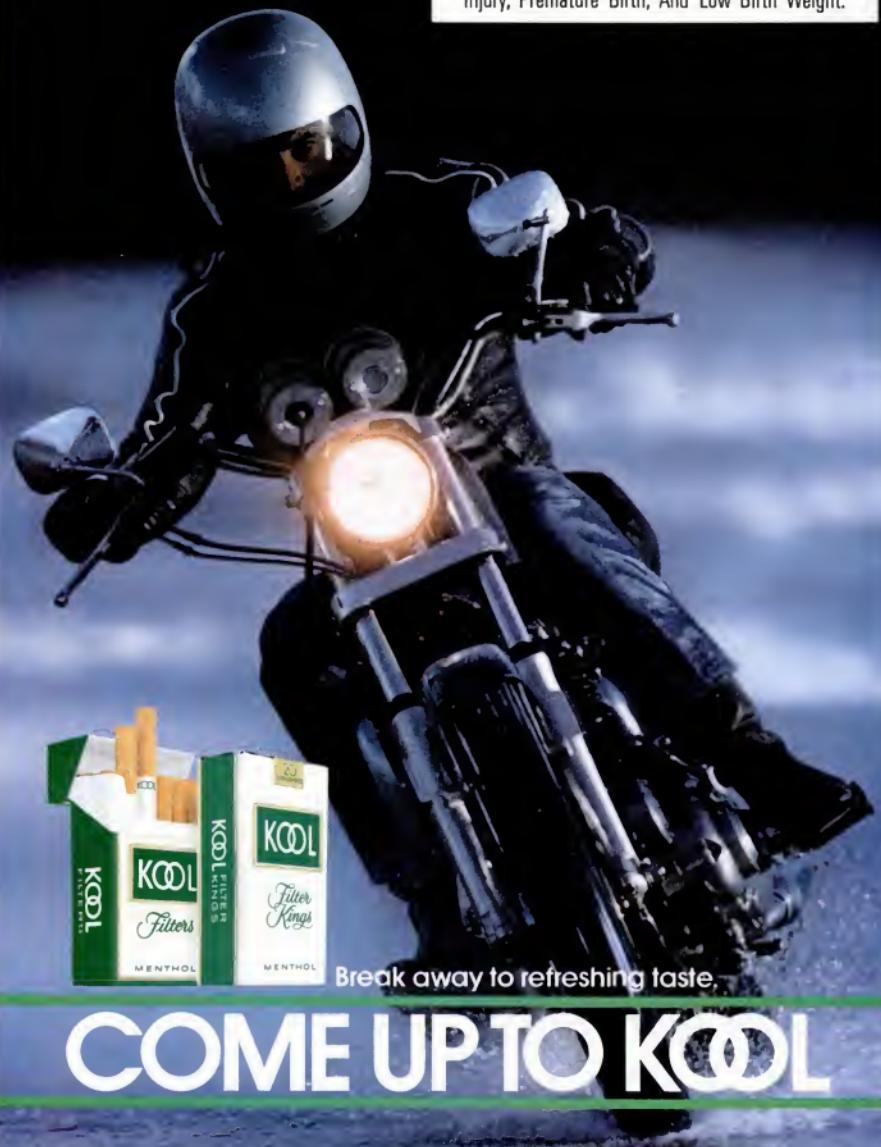


including occupants, equipment and cargo.
*World's Automotive Reports combined 4x2 & 4x4 Pickups, CY 1985.
**1985 J.D. Power & Associates Compact Truck Customer Satisfaction
Index for 1985.
†Only truck driver with a 4x2 engine option.

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Kings Box, 16 mg. "tar", 1.1 mg. nicotine; Filter Kings, 16 mg. "tar", 1.0 mg. nicotine av. per cigarette, FTC Report Feb. '95.

Windclipper prototype, based on a modified Kenworth chassis, features high-mounted driver's cab rigidly attached to the trailer. Powertrailer unit pivots below the cab. Controls run through fifth wheel.



TRUCKIN' INTO THE FUTURE

Slick new trucks are already on the road,
but the best are yet to come.

Among truckers, there may still be scoffers who think aerodynamic shapes like droop hoods and air deflectors are too dainty to fit the image of a tough, powerful road machine. But if the experience of car designers is any clue, the scoffers will dwindle in number as the tally of wind-cheating shapes in the big haulers' fleets continues to grow.

The automobile companies' first efforts at aerodynamic car bodies were criticized as "the melted candy bar look." But now, aerodynamic bodies are fully accepted as the normal way to construct a sedan.

That's what insiders look for in the truck designs of the future—cabs that not only make sense in saving fuel costs, but that appear completely different from the traditional broad-shouldered, level hoods of most current models. The changes have already started.



BY JIM DUNNE, Detroit Editor

Trucks from a number of the bigger makers—especially White, Kenworth, Peterbilt and Freightliner—are primarily designed to slide through the air at 55 mph with the least amount of resistance. At the same time they lose little of the macho style that truckers seem to prefer in their rigs.

The benefits of the new designs are more than just big money savings from improved fuel economy. New designs will also deliver:

- Lower noise levels inside the cabs and outside on the road.
- Much more room inside the cabs of the taller trucks.
- Better handling, especially when heavy winds buffet the semis from the side.
- Better forward visibility over hood and fenders.

In addition, if the truck and trailer panels are shaped carefully, brakes and tires will run cooler, operate more efficiently and probably last longer than those on today's models.

The switch to aerodynamics in trucks has been going on for just about 10 years, and today it's a rare semi tractor that is sold without at least a rooftop airshield. Many of the truck owners are choosing more elaborate aero systems, those that add side extenders and integral sleepers to cab contours designed in the wind tunnel.



"Ninety percent of my customers order air shields, at least," reports John Dermody, owner of Dermody Truck Sales in Grand Rapids, Michigan.

The idea of the air shield is simple enough. Things like lower hoodlines, split windshields and shields atop the roofs help the air pass over the tractor-trailer rigs without encountering massive air resistance. With less resistance, the engine works easier, noise from buffeting decreases, and performance improves. Handling also is said to improve, whether the wind is coming head-on or at an angle.

So-called concept trucks like Mitsubishi's MT-90X, the Renault VE 10 or Freuhauf's similar 2000 give a broad hint of what the correctly shaped truck of the future might look like. The Mitsubishi is just a slick 6-wheeler—imagine it as the Ryder Rental truck of the future—not a tractor-trailer rig.

On the cab-over Freuhauf and Renault the critical gap between the back of the tractor and the front of the trailer is filled in by flexible panels that give a 1-piece face to the wind, especially to side or cornering winds that raise havoc with fuel economy and handling at high speeds. Other wind-grabbing pockets around the wheels and beneath the cab are covered to smooth air passage.

Further out in the future are more radical designs that actually reshape the chassis of the truck. The outstanding example of this type is the Wind-clipper model conceived by Professor Richard Thomas of Oklahoma State University. In Thomas's truck of the future, the cab is locked directly to the trailer and moves with it as a unit.

A fifth wheel arrangement connects the driver's cab to the chassis, so the chassis/tractor unit turns while the cab remains aligned with the trailer. Remote-control connections for engine,

Penske Racing Team's modified Freightliner sleeper has a C_d of 0.462—about half that of a conventional 18-wheeler. Hinged side panels close gap between tractor and trailer, but still allow 90° turns.

Starting Goodyear proposal (right) has a high-mounted cab for maximum visibility. A gaping hole between the cab and tractor lets air pass through to rounded trailer.



steering and brakes snake through the center of a kingpin in the fifth wheel.

Benefits in Thomas's design include a high driver position for better visibility, stand-up roof height inside the cab, access to the trailer through the rear of the cab, more load on the front wheels

and a constant line of sight to the trailer sides when turning. The driver also rides on the trailer suspension, which may be more comfortable than that of the tractor.

Freuhauf, being a trailer manufacturer, has many innovations for the





Mitsubishi's MT-90X 6-wheeler was shown at the Tokyo Motor Show. Sleek shape has a C_d of only 0.38—less than many cars. Single tires, rather than duals, cut rolling resistance. Interior (left) is palatial.

Futuristic Renault VE 10 cab-over semi (below) has enclosed wheels and flexible panels between the tractor and trailer to reduce wind turbulence and drag.

trailer on its 2000 prototype, including shielded wheels and tires and an unusual boat-tailed rear end that narrows at the back to reduce drag by 9 percent. Clamshell doors allow full-width cargo to be loaded aboard.

Actual on-the-road experiences show that aerodynamics can save the highway trucker lots of money in fuel costs. That's why the traditional, big-shouldered shapes of tractors with side exhaust stacks, sun visors and exposed fuel tanks are being discarded in favor

of the more rounded, enclosed look.

"We figure that air shields alone will improve fuel economy by 10 percent," explains Dermody. "That figures out to half a mile per gallon or, on an older truck, an increase from 5 mpg to 5.5 mpg. If you run 200,000 miles per year, which is not unusual for these rigs, the savings is almost \$4000 per truck (comparing \$1 per gallon diesel). Then you add the other aero improvements and the savings go up from there."

Larry Fedrigo of Ladd Co., a long-haul trucking firm out of Livonia, Michigan, just added two 349H Peterbilts to his 7-truck fleet, and says the aero shapes plus other improvements have boosted fuel economy by 1½ mpg, "and they're not even broken in yet."

"We look to save \$8000 per year with each of the new trucks," says Fedrigo. "But I also noticed some improvements in handling. Whether it's the new high traction tires or the aero shields, I'm not sure. I drove through a snowstorm from Flint to Detroit with an empty trailer and felt the truck held the road much better than our older rigs. There was no slippage at all. Maybe it comes from the downforce of the air shield. That device puts a big load downward on the top of the cab."

One of the most dramatic aerodynamic semis now in service belongs to Roger Penske's Indy car racing team. It is a highly refined Freightliner cab-over-engine tractor with a Great Dane enclosed trailer. Improvements in the cab include a custom-made air shield and cab extender that makes the tractor and trailer look like a single piece. The side panels between the back of the cab and trailer are movable, so they are pushed out of the way when the rig is turning. Wheel covers are used to smooth out the airflow near the pavement. The front bumper was enlarged



to sweep away air that could create turbulence under the cab and trailer.

Famous car designer Larry Shinoda was responsible for the Penske design. He says the improvements reduced the coefficient of drag to 0.462—almost half that of the average semi without aero tweaking—and boosted fuel economy to an incredible 8.3 mpg. That marked an improvement of almost 3 mpg (over 50 percent) from the semi Penske Racing was using earlier.

"And the drivers like it better," Shinoda adds. "There's less wind noise in the cab, because there's less turbulence outside. In the older trucks, our drivers had to put on earphones when they wanted to hear their tapes. Now they can listen to the truck's speakers."

There are a lot more changes in the cab design than first meets the eye. In all, Shinoda and Penske added 700 pounds of plastic panels, aluminum framing and stainless steel to the basic cab. The movable cab extender at the sides push out when the truck turns by sliding on Teflon rub strips. They will kick out to a full 90° in the sharp turns needed for parking. The panels must be manually closed if they go beyond 80°, but two gas shocks per side keep them flush at lesser angles.

While the Penske tractor is a cab-over type, designers figure that the conventional cab, with its smaller frontal area, will be the major aero shape of the future. You don't have to be an expert in aero theory to understand why. The flat surfaces on the front of the cab catch the wind like a sail. Bend those surfaces, and reduce the flat spots, and you can cheat the wind. With conventional cabs, only the front of the

radiator opening presents a large flat surface. And it's much smaller than the flat face of a cab-over type. Truck retailers think that conventional cabs will once again gain dominance over the cab-over design for that reason.

Goodyear made a study of truck shapes a couple of years ago and had several startling suggestions to avoid



Tapered nose of Kenworth T600A—already on the road—penetrates the air better than blunt cab-over designs. Fuel economy is 22 percent better than standard designs.

the flat face of cab-over styles, including one that had a large hole in the lower portion of the cab to let air pass through the tractor. Another offered a "pinched waist" cab that placed the driver high above the wheels, atop a pedestal-type arrangement.

Early attempts at creating aero designs ran into some serious trouble. When aero shields were first used atop the cab, owners found that the pressure of the wind on the shield wreaked havoc on the cab roofs.

"Those shields were attached to the sheetmetal," Dermody recalls. "After a while, with metal fatigue and long trips at highway speeds, the sheetmetal would peel back, like opening a sardine

can. Or, sometimes, the front of the roof would raise up, break away from the windshield, and the glass would fall out. That was a mess."

Now, though, Dermody points out, just about all the trucks he receives from the factory have mounting brackets that are strong enough to carry the shields for the life of the cab.

Goodyear and others found that you can't just cover up the wheel openings in the cab and trailer and get good results. Brakes and tires will lose the flow of air that keeps them cool. Then the brakes fade and tires wear out prematurely. It has been suggested that fans be installed at the axles to make certain brakes and tires get the full measure of cooling air.

Yes, there is more to improving truck economy than aero improvements. Just as important are tires with low rolling resistance, and engine/transmission packages that are specifically designed to produce peak torque at 55 to 60 mph. In addition, the use of single wheels on axles to replace duals gets rid of a lot of rolling resistance. Tires and wheels have to be uprated to maintain the load capacity of an 18-wheeler running on only 10 wheels.

Despite today's lower prices for fuel, it appears that the trucking industry will continue to aim for that magic goal of 10 miles per gallon. So look for more elaborate aero designs, more radical cab arrangements, some extensive changes in trailer shapes, and fewer blown tire treads littering the roadway. Bringing together what the aero specialists know now, and mixing in high-technology engine controls, the 10-mpg semi is a reachable goal.

Big Red Was Here Afore Ya, Pardner

One of the first aerodynamic tractor-trailer combinations was this experimental Ford gas turbine rig called Big Red. It was introduced in the late 1960s, well before high fuel prices started a scramble for ways to in-

crease miles per gallon. Back then, some of today's aero techniques were well known. Note the high-level cab that acts as a wind shield to direct air over the trailer. Extensive skirting around the wheels kept turbulence to a minimum.

And tight clearances between the cab and trailer shut off many of the effects of crosswinds cutting between the two. Ford stopped talking about Big Red shortly after its introduction, when the turbine engine did not work out.—J.D.



PM COMPARISON TEST



JUNIOR GTs

Japanese invade the mini GT market! We test eight small Grand Touring cars and find them amazingly matched.



Nissan's wedge-shaped 200SX Turbo (top) is one of only two rear-drive cars in the group. Stylish Isuzu Impulse (above) has Italian bodywork atop a 140-hp Chevette chassis!

Talk about a competitive test! For five years, Volkswagen's delightful Scirocco has been the yardstick against which other small GT cars are measured. Yet in our test, it finished last behind seven newer and even more terrific sports coupes from Japan. It's a textbook example of what happens when you relax on your reputation.

In addition to the Scirocco, our Junior GT group includes the popular Honda Prelude in its most powerful 2.0 Si form, Toyota's brand-new 16-valve Celica GT-S, plus five hot turbocharged sports—the Isuzu Impulse, Mazda 626 GT, Mitsubishi Cordia, Nissan 200SX and Subaru XT.

Remarkably, all eight miniature *Gran Turismos* are almost exactly the same size (about 170 in. long), the same

weight (about 2500 pounds) and all, except Nissan's 200SX and Isuzu's Impulse, are front-wheel drive. All eight have a 1.8- or 2-liter 4-cylinder engine backed up by a 5-speed gearbox, and all except the Honda, Subaru and Mazda are hatchbacks. We can't remember when we've tested a more closely matched group of cars.

And never have we tested a more consistent group. Not only do all eight perform about the same, their overall performance is astoundingly high—especially when you consider the price and size of these cars.

For between \$12,000 and \$16,000, these 2-liter coupes offer performance on a par with many more expensive and pretentious sports cars. We think *any* of them would be tough to beat for everyday driving fun.

Honda Prelude 2.0 Si

Our favorite Junior GT is Honda's Prelude, but only in 2.0 Si trim. Even with this more powerful engine, the Prelude is still down on power compared to the turbocharged and 16-valve competition. Still, the Prelude reminds us most strongly of a Mercedes-Benz, particularly the 560 SL coupe. Neither is a standout at the track, but both have the same effortless feel that makes them absolutely delightful to drive—on any road, at any speed.

It's no secret that Honda Motor Co. has patterned itself after Daimler-Benz AG, and if any \$14,000 car can be said to feel like a \$60,000 Mercedes, it's the Prelude. The Prelude is derived from the Accord, which means it shares not only drivetrain and chassis components, but the Accord's new suspension.



Toyota's Celica GT-S (top) was the most fun to drive, but tubby styling lost it points.

Mazda 626 GT Turbo (right) was the hands-down winner on the test track. It gained points for roominess and practicality.

Mitsubishi Cordia Turbo (below) had mid-pack performance and quirky styling.

Instead of simple MacPherson struts, Honda engineers have returned to the classic design of equal-length upper and lower control arms with coil springs and separate shock absorbers. This virtually eliminates camber change during cornering. The Prelude was first on the skidpad and third in the slalom, but more important, it has superior directional stability at all times.

Our testers called the neat notchback styling classic, tasteful and unpretentious. The 2.0 Si has a small rear spoiler, which adds to the sporty lines. The front grille is admittedly busy, but we think the Prelude looks like a very model of the modern Junior GT.

Inside, things are just as special. The ergonomics are superb for the driver and passenger, though obviously cramped for those in the rear seats.

Most remarkably, not only is almost everything right with the Prelude, we



had a hard time finding anything wrong. The larger drivers in our group thought the seat bottom needed to be longer for better thigh support. Other than that, our group uniformly ranked the Honda Prelude "wonderful . . . purrfect . . . dynamite."

The Honda was not a unanimous first choice. Our major dissenter called it, "neither fish nor fowl. It's not as much fun as a CRX and not as practical as an Accord."

Toyota Celica GT-S

The Celica is a triumph of engineering. The all-new front-wheel-drive chassis is superb, nimbly zipping to first in the slalom and second in our skidpad testing. The new 4-valves-per-cylinder, double-overhead cam, 135-hp engine

loves to rev, and it gives the GT-S the same happy feel as the similar engine in the Corolla GT-S and MR2.

The Celica raced to third in acceleration, running the quarter-mile in 16.176 seconds at 85.02 mph—remarkable performance for a 2-liter car without a turbocharger. All together, the Celica sped to second overall at the track, and impressed our track tester. It's very nippy and precise, like driving a nervous, high-strung racing car.

Of course, if all you're trying to do is pick up a 6-pack of wine cooler from the corner deli, you may not want to deal with a thoroughbred's raspy exhaust, wish-quick steering and off-beat driving position. But in the Celica, *every* trip is practice for LeMans. Where the Prelude is relaxing and confidence-inspiring, the Celica is exciting and adventuresome.

The Celica interior is very comfort-





Subaru XT Turbo (above) got mixed reviews on unusual exterior and interior. Performance was adequate but not exciting.

Volkswagen Scirocco (left) will soon get a much-needed 16-valve engine with 123 hp.

Honda Prelude notchback (below) was ranked first on the road, third on the track.



able. Analog gauges sit right where they should be, and our test car's gray interior was nicely harmonized into a driving environment that rivals the Prelude's in its "Mercedesness."

The Toyota's styling got very mixed reviews. As one of our group put it, "The Celica is a really fun car to drive, too bad it looks like a potato with spoilers." "Looks like a pregnant Isuzu," wrote another disappointed tester. Summed up a third critic, "I bet they restyle this body *real soon*."

But you can't displease all of the people all of the time. One tester wrote: "This car has the slick aerodynamic look everyone else is working toward. It's three to five years ahead of its time."

The new Celica is more fun to drive than any of the competition, including the more "mature" Prelude. It's beautifully put together, and a real rocket. But we think the styling will turn off a lot of people, as will the price. Our full-tilt GT-S carries a healthy \$2000 premium over the Prelude.

Mazda 626 GT Turbo

Mazda's 626 is a competent 4-door sports sedan aimed at the Honda Accord, but falling one engineering cycle behind. The 626 GT is the 2-door version, now fitted with a turbo that extracts 120 hp from the conventional single-overhead-cam 2-liter Four.

What a difference a turbo makes. The

626 GT Turbo is a clear half-second and 2 mph faster through the quarter-mile than the all-new RX-7 2-seater, and just as fast through the slalom or around the skidpad. It also has better brakes than the other Junior GTs.

On the strength of its performance and all-around utility, our testers voted the 626 into third behind the Prelude and Celica. We found the styling pleasant, dated and bland, but also much easier to wake up to every morning than the Celica. The interior was praised for its room—the largest in this group—its excellent seats and good driving position.

Our testers universally disliked Mazda's electronic dashboard, the "old bath towel" used to upholster the seats and the generic Japanese interior decor.

More than any of its competitors, the 626 GT fails to hide its sedan origins. This makes it less stylish perhaps, but also more functional.

As one of our group nicely summed it up: "This is not a trend-setter like the Prelude nor a memorable drive like the Celica, but it is a quick, pleasant-looking car with an excellent reputation for reliability, at least in nonturbo trim. The turbocharger will probably add trouble and expense, but the kick in the pants when you put your foot down is worth it."

Isuzu Impulse Turbo

The Impulse combines a brilliant initial concept with five years of progressive development. The result is the most seductive small car on the market. The



JUNIOR GTs

impulse for the Impulse came from Italian stylist Giorgetto Giugiaro, who originally offered this body to Volkswagen as the next Scirocco. VW declined, so Giugiaro sold the idea to Isuzu. Isuzu put Giugiaro's gorgeous body on the only chassis they had, a license-built version of the Chevrolet Chevette.

Since then, the Impulse's Chevette origins have been almost entirely eradicated, except for the old-fashioned rigid rear axle. It now has 4-wheel disc brakes, a slick 5-speed and a 2-liter single-overhead cam engine, turbocharged, intercooled and rated at 140 hp—more power than any other car in this class.

This marvelous engine shoved it to first in acceleration at an excellent 15.811 seconds and 87.97 mph in the quarter-mile. This is faster than all but a few V6 and V8 musclecars, making the little Impulse one of the hottest rides on the road.

The Impulse also has excellent brakes. Unfortunately, the old-fashioned suspension put the Impulse near the bottom in our handling tests. It's not a handful in any way, indeed it's fun to drive on the road. But at the limit, the Chevette suspension is easily upset, and the Impulse lifts the inside rear wheel, bobbles and plows.

We have to emphatically make the point, however, that you'll never force the Impulse to lose its composure on the street. The Isuzu averaged fourth overall at the track and fourth in the hearts of our road testers.

We all loved the exterior styling, calling it the prettiest small car on the market, and saying that more Japanese companies should do their styling in Italy. Despite the add-on spoilers that detract somewhat from the look of Giugiaro's original show car, this is still the

only auto-show styling exercise that you can buy for the road.

Our Italian Racing Red coupe contained a classic tan leather interior that's as un-Japanese as could be. The only jarring note is a video game instrument panel that would be more appropriately replaced with classic white-on-black gauges.

Otherwise, we like the ambience of the Impulse. The leather seats got high marks for their perfect array of adjustments, including lumbar and seatback wings, while the Audi-like controls were praised as amazingly convenient and easy to operate. Every tester remarked on the unorthodox turn-signal—a huge switch that protrudes from the dashboard—and how much easier it is to use than the conventional column-mounted stalk.

All in all, we think the Impulse is quite the small car. It's lovely, it's richly appointed, it's comfortable and it really moves.

As one tester summed up: "Only two things keep the Impulse from being the car I'd like to own: engine vibration and suspension harshness. Otherwise, this is a great car. And such style. Where else can you buy a designer original for off-the-rack prices?"

Mitsubishi Cordia Turbo

There's a definite gap between the top four cars in this test—any one of which should bring long-term happiness to your garage—and the bottom four. This is not to say that the Cordia is a bad car, it's just ordinary.

Styling is smooth, but the awkward grille and add-on fiberglass "go-fast" doodads spoil the overall effect. The fit and finish is typically good, except for

those tacky add-ons. Our testers were clearly uncomfortable in the Cordia. The interior was described as lousy, confused and junky, with tacky moleskin upholstery. Different colors, textures and materials make it really distract. The driving position was criticized because the wheel is too high and seat too low, and the controls are confusing. The analog instruments were praised, however.

Driving the Cordia is a pleasant surprise. It's not as fast or refined as the competition, but our testers found it smooth, comfortable, stable and easy to live with. As one tester put it: "I expected more oomph with the turbocharged engine, but the general driving demeanor is fine overall. It just lacks excitement."

Nissan 200SX Turbo

We were disappointed by the 200SX. This model has been a demon in IMSA and SCCA Showroom Stock racing, and we expected it to make short work of the competition in our track tests. Imagine our surprise when the 200SX was out-run, out-handled and out-braked by a variety of less macho cars. It ended up fifth in our track tests.

Unfortunately, the Nissan showed no compensating finesse in the road-going portion of our evaluation. Our test group voted it seventh, ahead of only the Scirocco. The rear-drive 200SX is getting rather long-in-the-tooth and we think it's overdue for replacement.

Our testers were surprised at how unrewarding the 200SX is to drive: "It feels like a big, heavy car. It's clumsy, and not much fun," complained our track tester. The shifter is notchy, the steering is woefully light with a wobbly feel, and serious handling instability makes this car real work to drive fast.

TEST RESULTS

CAR	GAS MILEAGE (EPA city/PM test)	1/4-MILE (sec. @ mph)	SLALOM ¹ (mph)	SKIDPAD ² (cw/ccw)	BRAKING (ft.) (60-0 mph)	TRUNK CAP. INDEX ³	INTERIOR SPACE INDEX ⁴	TEST TRACK RANKING ⁵	ROAD TEST RANKING ⁶	OVERALL RATING ⁷
Honda Prelude 2.0 Si	25/22.9	16.680 @ 81.95	60.52	.80/.83	146	9	100.14	3	1	1
Isuzu Impulse Turbo	22/20.8	15.811 @ 87.97	59.18	.77/.80	130	9	98.80	4	4	4
Mazda 626 GT Turbo	22/21.6	16.015 @ 87.08	60.45	.77/.81	117	13	106.60	1	3	3
Mitsubishi Cordia Turbo	22/19.9	16.419 @ 83.79	59.32	.75/.78	156	8	103.50	6	6	5
Nissan 200SX Turbo	22/19.9	16.620 @ 81.85	59.18	.78/.83	132	9	95.70	5	7	6
Subaru XT Turbo	25/19.5	17.048 @ 80.00	60.83	.73/.81	159	12	96.24	8	5	7
Toyota Celica GT-S	23/22.9	16.176 @ 85.02	62.25	.81/.81	133	14	93.84	2	2	2
Volkswagen Scirocco	26/30.4	17.358 @ 78.56	58.30	.79/.80	140	8	90.80	7	8	8

1. Best speed achieved while weaving through seven cones placed 100 feet apart; the higher the speed, the better the transient handling.

2. G-forces generated during steady-state cornering around a 200-foot-diameter circle; cw = clockwise, ccw = counterclockwise.

3. The number of standard-size grocery bags that will stand upright (1-inch crush space permitted) in the trunk.

4. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom ÷ 1000.

Our testers weren't especially taken with the 200SX's styling or interior, either. Said one, "It's very '60s in feeling, with awkward transitions." Others mentioned the low seat, awkward driving position and an Op-Art interior that's too busy. It also has one of those annoying talking dashboards that tell you when "The key is in the ignition." These synthesized nags are a throwback to another era. This year, Nissan's redone 80 percent of its line, offering a new Sentra, Stanza, Maxima and pickup. We wouldn't be surprised if a new 200SX is in the pipeline, too.

Subaru XT Turbo

Most of our testers had a hard time coming to grips with Subaru's Junior GT. "This is a weird fish if ever I saw one. It's too off-beat for me," wrote one bewildered driver. Not everyone agreed. "This is the only 1986-style car in this group," proclaimed a Subaru champion, "the wedge is modern and sporty." If nothing else, the styling is certainly controversial.

The interior is just as unusual as the exterior. Among the most noticeable features are an asymmetric steering wheel, a knobless shift "bat" and one of the most elaborate electronic dashboards on the market. Our testers described the "lizard scale" upholstery, awkward control pods and speed alarm, though the seats, driving position and visibility were all praised.

The XT is built on the same chassis Subaru uses for all its cars, and while it doesn't handle as well as the Mazda, Honda or Toyota, it's a paragon of dependability. The turbo brings the power up to acceptable levels, but the XT will never be accused of being overpowered. At the track, the XT shone only in the slalom, where its quick steering and sticky tires helped it

to second in the class. The best thing about the XT is that, like any Subaru, it can be ordered with 4-wheel drive. Obviously, you're not going to go off-roading in a needle-nosed sports coupe, but the XT is a far less expensive way to enter the sporting 4x4 ranks than something like an Audi Quattro. The XT is at the cutting edge of technology. It's just not very raucous and not everyone's cup of sake.

Volkswagen Scirocco

Someday soon, Volkswagen dealers will be offering the Scirocco 16V—VW's answer to the Japanese turbos. It will feature a 16-valve head and 123 hp, 4-wheel disc brakes and bolt-on fiber-glass bits. After testing the Scirocco head-to-head against the Prelude, Celica, and other Junior GTs, we'll give VW a little free advice: What you need is a whole new car.

The current Scirocco is built from the Golf chassis, which similarly suffers in comparison with the latest Japanese economy cars. VW made its reputation tinkering with the Beetle over a period of 40 years. Honda and Toyota are programmed to replace their current models with a whole new line every three years, whether they need to or not. Tinkerers simply can't compete with that.

This is not to say that the Scirocco isn't an appealing car. The styling is similar to that of the Impulse. The interior is refreshingly European, with a noticeable lack of digital instruments and electronic gizmos. Performance—while modest in every way—is predictable and easy to control.

In sum, the Scirocco is an innocuous, unpretentious car that, as one of our group put it, "is cramped, uncomfortable, and 10 years behind the times. It feels high, narrow and tippy, and the

engine vibration is inexcusable. It may be a German road machine, but the ergonomics are laughable and the performance tepid."

Conclusion

The Honda Prelude is so good it transcends this class to earn a place as one of the best cars on the market. We'd like Toyota's Celica GT-S as much as the Prelude, if only it didn't have such a bad case of the uglies.

Mazda's 626 GT Turbo may not make your pulse race to look at it, but drive one and see if it doesn't put a smile on your face.

If you want a bona fide work of art



Winner, by a whisker: Honda's Prelude. Only dealer price-gouging dims its appeal.

that just happens to be one of the quickest, neatest little coupes on the road, treat yourself to an Isuzu Impulse Turbo. The styling, interior and drivetrain are all superb. The chassis is adequate. Three out of four ain't bad.

The next four cars in this group—the Mitsubishi, Nissan, Subaru and VW—are all more than adequate, but they are definitely a cut below the top four. The gap between the first-place Honda and fourth-place Isuzu is smaller than the gap between the Isuzu and Mitsubishi. There's not a bad car in the group. Four of them just have a lot more appeal than the remainder.

SPECIFICATIONS AND DIMENSIONS

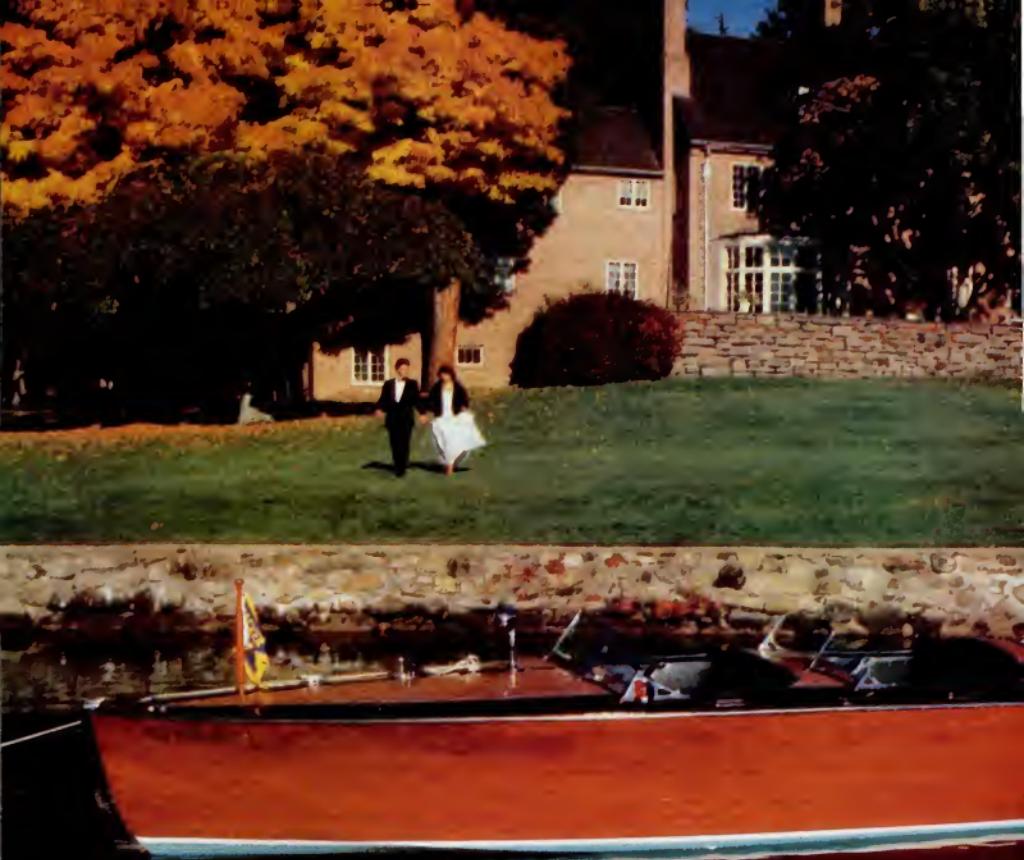
VEHICLE TYPE	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEEL-BASE (in.)	LENGTH (in.)	WEIGHT (lb.)
4-passenger 2-door	\$13,538	\$13,727	110-hp SOHC 2.0-liter inline-4	5-speed manual	97.7	169.1	2250
4-passenger 3-door	\$14,439	\$15,468	140-hp SOHC 2.0-liter inline-4 turbo	5-speed manual	96.1	172.6	2750
4-passenger 2-door	\$12,595	\$14,320	120-hp SOHC 2.0-liter inline-4 turbo	5-speed manual	98.8	177.8	2400
4-passenger 3-door	\$10,369	\$12,019	102-hp SOHC 1.8-liter inline-4 turbo	5-speed manual	96.3	173.0	2350
4-passenger 3-door	\$13,069	\$15,364	120-hp SOHC 1.8-liter inline-4 turbo	5-speed manual	95.5	174.4	2650
4-passenger 2-door	\$13,343	\$13,791	110-hp SOHC 1.8-liter flat-4 turbo	5-speed manual	97.1	175.2	2490
4-passenger 3-door	\$12,698	\$15,833	135-hp DOHC 2.0-liter inline-4	5-speed manual	99.4	173.6	2650
4-passenger 3-door	\$9980	\$12,310	100-hp SOHC 1.8-liter inline-4	5-speed manual	94.5	165.7	2200

5. Points are awarded from best (1) to worst (6) in each category. The car with the fewest total points ranks first, next lowest second, and so on.

6. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.

7. Average of Test Track and Road Test ratings. Ties are decided in favor of Road Test score.

Bold numbers indicate best performance.



SPLASH FROM



Triple-cockpit runabout from Grand-Craft borrows its line from Chris-Craft.



John Hacker inspired this Saint Marine replica.



The beauty of the old, the practicality of the new coalesce in this 30-foot Hackercraft by Morgan Marine.

Modern-day construction enters the world of old-time powerboating.

BY TIM COLE
Boating/Outdoors Editor

If Stradivari had fiddled with boats instead of violins, he surely would have seen fit to create this gleaming specimen of varnished Honduran mahogany. From cutwater to transom, she's a magnificent blend of antique, 1920s styling and modern-day functionalism. Brushed aluminum instruments are set like gems in her shapely dash. Soft leather upholstery covers her athwartships bench seating in each of three cockpits. A musclebound Crusader 335 lurks beneath her engine cowl, ready to hurl this stately ensemble across America's lakes and inland waters—but also across time. She's a bridge to another age, a connection between the glamour of the past, the technology of the present. And she's so beautiful she produces the same kind of breath-stealing palpitations of the heart that accompanied your first teenage romance.

We're talking about simple lust.

But let's progress, if we can, beyond emotion—to the more intellectual side of reproduction runabouts. These classics borrow from boat de-

THE PAST



A Don Philbrick original draws from classic themes.



This Streblow is a modern version of a '60s sport boat.

SPLASH FROM THE PAST

signs in vogue a half-century ago and duplicate them using modern materials and technologies. A handful of firms scattered around the nation are producing these nautical *objets d'art* at costs between \$20,000 and \$70,000. They're a little pricey, sure, but for the marinercum-connoisseur, they're the perfect accoutrement to a waterside lifestyle. And in every instance, they're built better—much better—than the predecessors from which they draw their altogether pleasing lines. Offer a tip of the hat to modern epoxies, polymers and cold-molding.

Consider the three Hackercraft designs currently being produced by the ever-congenial Bill Morgan at Morgan Marine on the shores of Lake George, New York. Morgan began his lifelong love affair with Hacker-designed runabouts when he was a kid. His dad owned a 26-foot Hacker that was built in 1927. "I always thought Hackers had the most pleasing lines, the best work-

manship and quality," Morgan says.

After restoring several original Hackers at his Lake George shop, Morgan decided it made more sense to create new Hackers from the ground up rather than resurrect the old-timers. Morgan found the last owner of the moribund Hacker Boat Co., purchased the rights to the name and the designs, and his 10- to 12-man staff of local talent went into production. The firm produces about 10 boats a year—triple cockpit cruisers in 24-, 26- and 30-foot lengths that range in price from \$35,000 to \$45,000. Hacker used white oak frames in his original designs, with Honduran mahogany planking and cedar bottoms. Morgan retains this schedule of materials, except for the bottom, which, in contemporary form, is also made of mahogany.

"Wood is wood," says Morgan. "And what was available back in those days is still generally available. The basic difference is that our new boats include about 25 percent more frames. We've also done away with brass rivets and fasteners, and doubled all the timbers across the keel and out at the chine. The boat is now epoxy-glued and encapsu-

lated to eliminate dry rot. Our battens are heavier and we use a bedding compound on the planks that gives much longer adhesion and basically a much stronger structure. The end result is a different boat from the original Hacker. It rides at the same attitude, but it has a much different feel because it's much more solid."

The late John Hacker also supplied the inspirational momentum at Hugh Saint's Saint Marine in Cape Coral, Florida. Saint builds a triple-cockpit Hacker design that's been strongly influenced by naval architect Douglas Van Patten, a personal friend of John Hacker. Saint, who apprenticed as a shrimp-boat builder, offers two power options on his 23.5-footer—derived from either a 302-cu.-in. Ford block or a 351. Like Morgan, Saint relies on modern epoxies in crafting his Hacker, namely the WEST (Wood Epoxy Saturation Technique) building system marketed by Jan and Meade Gougeon of Bay City, Michigan.

"We're multilayering areas to stabilize the surface," Saint says. "My bow stem, for instance, is 37 layers of $\frac{1}{16}$ -in. Honduran mahogany at the widest



Magnificent \$18,000 Gale Banks 454-cu.-in. power option (left) is an intercooled engine with twin turbos and a single Holley 4-barrel carb. Integrated gauges (lower left) are from Classic Instruments of West Linn, Oregon. Meticulous attention to detail (above) is put into two Hackercrafts as they're framed and planked. The 30's cockpit (below) is where hull construction, upholstery and engineering come together.



Tim Gautreau "does a little bit of everything" at Morgan Marine, where modern-day Hackercrafts are born, making him one of America's leading experts on classics construction. According to Gautreau, it all begins when prebuilt white oak frames made from John Hacker's original patterns are set up in a jig. Then, major portions of the boat's skeleton—keel, chines and transom, for instance—are fastened to the frames, and battens are laid over the resulting structure.

The boat is then triple-planked with two layers of $\frac{1}{4}$ -in. Honduras mahogany veneer, laid diagonally, along with a $\frac{1}{8}$ -in. outside linear layer. The planks are bonded to the frames with 3M's 5200 fastening compound, a material often used in fiberglass construction to join hulls and decks. The bottom is then sheathed in epoxy and painted. A single layer of Honduras mahogany is fastened to the topside frames and battens to form the deck.

Ten to 12 coats of varnish are applied to the hull at this stage, with mahogany seam compound implanted between the deck seams. The seam compound is later painted white. The Hacker's original deck gear—lifting eyes, bow chocks, running lights, air scoops—is cast from molds taken off antique accessories, machined and then chrome-plated. Morgan offers the Crusader powerplant standard in various displacements, but custom engines, like the Gale Banks 454 (above left), can be installed.—T.C.

point. The keel, the chines and the planking are of inner diagonal African mahogany and the outer horizontal layer is of Honduran mahogany."

Saint's next project? A 28-foot Van Patten-designed derivative of the old Canadian Greavette. "These were built between '33 and '56 and are really famous to antique-boat collectors and restorers."

If old Mr. Hacker supplies a crucial historical link to products offered by Bill Morgan and Hugh Saint, Christopher Columbus Smith furnishes a similar association at Grand-Craft.

Smith was the founder of Chris-Craft, and the Grand-Craft plant, owned by Richard Sligh, is located in Holland, Michigan, one of Chris-Craft's original manufacturing sites. Many retired Chris-Craft workmen are now employed at Grand-Craft. Chris Smith, grandson of Christopher Columbus Smith, does all of Grand-Craft's drafting work and helps in initial construction.

Besides 24- and 27-foot triple-cockpit classics, powered by Chrysler engines from 240 to 350 hp, Sligh and crew also produce 20- and 23-foot sport boats of more recent vintage.

"On the classics," Sligh says, "we use the same construction techniques that Chris-Craft used years ago, like the double-planked mahogany bottom, but we've gone with modern sealants and adhesives that bond the entire bottom together so well that preseason soak-up is virtually unnecessary. Still, overall, we're committed to retaining Chris-Craft's traditional look and values."

But there still exists amid this stable of reproduction boats some totally original designs.

Don Philbrick of Oakland, California, has been building all-mahogany inboard runabouts of his own design for 52 years. Philbrick even makes his own cast-metal hardware. "Everything except the spotlight."

And the Streblow family of Kenosha, Wisconsin, has been in the business of building mahogany boats since 1954. But patriarch Larry Streblow has a more contemporaneous design philosophy: "Wooden cruisers are a thing of the past, so we concentrate on wooden sport boats." The resulting Streblows have modern, rakish lines and expand-

sive cockpits, playboats with a late '50s, early '60s flair.

Streblow is also a strong believer in establishing a compromise between looks and performance. His new 28-footer is powered by a pair of 275-hp 360-cu.-in. Chrysler engines. And the Streblow construction technique uses an interesting variation on the encapsulation theme expressed by some of the "classics" manufacturers.

"We have a solid marine plywood inner bottom, with canvas over that set in fungicidal treatment. Mahogany planking goes over that. Our boats don't require soaking or caulking. We use a high-performance polyurethane sealer on all fadable surfaces." Hull sides and deck are seam-batten construction stained and varnished. Teak is used for various trims, accents and in the swim platform.

And if you think interest in quality reproduction cruisers is limited to a few wealthy initiates, think again. You'll find powerboaters with an abiding interest in classics all over the country—



The HackerCrafts 30 (left) and 24 (right) in repose. Longitudinal seams are actually painted white. Metal hardware is cast from molds patterned after original equipment.

from the Florida glades, to the Midwestern dairy country to the Western mountains. And you'll find most true aficionados reading a delightful little magazine called *Antique and Classic Boat*, edited and published by Norm Wanguard.

"We are seeing many new people entering the field of classic boats," says Wanguard, "and they write a lot of letters looking for answers from an authoritative source. Sometimes it's overwhelming. We're also finding quite a lot of interest from advertisements in *Hemmings Motor News*, which suggests a close tie-in between people's interests in quality antique cars and boat restorations and replicas."

Wanguard has found a common psychological thread that binds people who own, or at least admire, antique or

classic boats. One of those people is Betty Cook. Betty has pulled back on the throttles now after winning world and national offshore powerboat racing championships back in the late '70s. These days, she drives a 30-foot Hacker on Lake George.

Her California company, Kaama, produces engines, steering gear and surface-piercing outdrives for recreational performance boats.

"I wanted a real lake boat," she says, "something that fit my lifestyle on Lake George and also something I could use to look at the scenery. I mean, you can see a lot of scenery at 65 mph on the race course, but not as much as you do in my Hacker. She doesn't make all that much noise. You can take a sharp turn without having your passengers end up in your lap, and you can drink a cup of coffee without wearing it. It's an *elegant* boat, and it gives me the same feeling I get when I'm wearing a mink."

Theron Van Putten of Grand Rapids, Michigan, who owns hull No. 1 of the 24-foot Grand-Craft, likes the utilitarian

aspects of owning a modern classic: "We really use that boat. And everywhere we go, plastic boat owners give us the thumbs up."

For Cook, Van Putten and others like them, the "classic" attitude extends beyond the simple appreciation of wood, metal and glass artfully assembled, to the way these boats lift the spirit—and make it soar. Move behind the wheel, push the chrome shifter into forward, open the throttles and blast through space to a simpler time. Back when mom and dad would take the cruiser for a twilight ramble. When that girl from across the lake would snuggle close in the moonlight to get out of the wind. When the family got all spruced up for a spin to the yacht club cotillion.

Can't you hear the ukuleles?

MANUFACTURERS AND SOURCES

- Grand-Craft Corp., 448 West 21st St., Holland, MI 49423; (616) 396-5450
- HackerCraft, Morgan Marine, Silver Bay, NY 12374; (518) 669-2222
- Philbrick's Boatworks, 603 Embacadero, Oakland, CA 94605; (415) 882-9443
- Saint Marine, 838 Southeast 9th St., Cape Coral, FL 33904; (813) 574-1299
- Streblow Custom Boats, 2319 Springbrook Rd., Kenosha, WI 53140; (414) 694-3222
- Antique and Classic Boat magazine, P.O. Box 1634-M, Colton, CA 92324 (\$20 per year, U.S., \$25 per year Canada)
- The Real Runabouts, c/o Bob Speltz, 505 Albert Lea St., Albert Lea, MN 56007; (507) 373-2145

ALL-AMERICAN

These days, American car buyers are running hard to scoop up every available example of the year's newest automotive star—the European-style GT. Manufacturers such as BMW and Mercedes-Benz have been long building their plush and roomy Grand Touring sedans with svelte styling and responsive suspensions for high-speed *autobahn* travel, while their engineers pack in as much performance wallop as they can squeeze between the gas mileage restrictions and emissions regulations.

Still, there's a minority of driving enthusiasts who demand even more luxury and performance than these factories deliver as standard issue. Those well-heeled buyers want more than the top production-line options offer, and want to show it off as well, with distinctive bodywork and custom appointments. Companies like the German-based AMG have made a reputation for themselves as an exotic car boutique by supplying everything from \$400 steering wheels to complete European-specification engines to the dedicated Mercedes buyer.

Since most of us aren't the type who

can drop an additional \$15,000 to upgrade a car that already costs \$30,000 or more, we chose to show what it takes to build an All-American GT car in the best European tradition. Our project was based on a 1985 Ford Thunderbird. We felt the sophisticated, high-tech, fuel-injected, turbocharged 4-cylinder engine was more in keeping with the European flavor than the 5-liter V8. The T-Bird was supplied by Bill Kolb of Faulkner Ford in Blauvelt, New York. Kolb operates two other businesses at the same location—Kolb-American Motorcars, a specialty-car conversion center, and Spoilers Plus, a specialty aero-style body panel manufacturer. Kolb-American did the conversion work for us using parts supplied by Spoilers Plus.

To give our T-Bird that AMG look, Kolb installed the air dam, rear spoiler, side rocker moldings, headlight covers and unique asymmetrical grille that make up his Aero GT package. The price tag on this package is \$662 (painting and installation each cost an extra \$150) and includes replacement strut



Spoilers Plus bodywork (above and at right) includes a deep chin spoiler to direct air up to the turbo intercooler, Lexan headlight covers to improve aerodynamics at the racetrack, a distinctive grille and fascia assembly and a smart rear spoiler. Together, the new parts give the PM Thunderbird a one-of-a-kind custom look.



GT

Luxury Grand Touring cars may be the trendiest new import, but here's one born in the U.S.A.

BY CLIFF GROMER



Rocker moldings [above] complete Spoilers Plus Aero GT package. Engine bay sparkle blinds the onlooker with stainless braided hose covers and meticulous detail [top left]. Sixteen-inch Gotti wheels [top middle] are a high-tech modular design with proper European breeding. Equalizer controls for Blaupunkt stereo are stalk-mounted [top right]. Below, Intercooled T-Bird out-accelerates stock version by a full second in quarter-mile.

PHOTO BELOW BY HUMPHREY SUTTON. PHOTOS ABOVE BY CLIFF GROMER

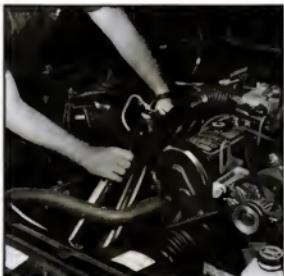


rods for the trunk to compensate for the extra weight of the rear spoiler.

With our Bird's exterior plumage in order, it was time to move the car up the automotive pecking order. The prime ingredient here was the bolt-on installation of a Ford SVO (Special Vehicle Operations) intercooler kit (Ford part No. M6775A231 sold by Spoilers Plus for \$399, installation \$195 extra by Faulkner Ford.). This piece is nothing more than an air-to-air heat exchanger that cools the incoming mixture and allows it to be more densely packed into the cylinders. The bottom line is a 35-hp increase over the stock setup. Kolb's entire package is designed so the front air dam directs more air up the intercooler, making it work more efficiently. Kolb also bumped up the ignition timing 10° and made sure the fuel tank was filled with premium-grade gas. Most important is that the Kolb-installed unit does not affect the new car factory warranty. That intercooler, by the way, is scheduled to become available from the factory on 1987 model Thunderbirds.

Kolb transformed our Thunderbird into a looker and a cooker, but we were far from finished. We also wanted an improved image when we lifted the hood, so we turned over the car to ace

(Please turn to page 104)



Intercooler pipes from SVO kit route pressurized turbo mixture through the front-mounted intercooler for a 35-hp boost.



Aluminum heat exchanger portion of the intercooler kit bolts into grille opening, where cooling airflow is strongest.



Gas shocks, special springs and stiffer sway bars are all part of Koni suspension kit developed specially for Thunderbirds.



Spoilers Plus front fascia (on floor) and grille are bolt-on replacements that add a bold custom look to All-American GT.

Now In America: Euro Boutique Chic

Credit the invention of the luxury hot rod to the AMG company, a customizer and specialty builder located near Mercedes-Benz's home of Stuttgart, West Germany. More than any other trait, AMG's trademark has been monochrome paint treatments, coloring every bit of chrome trim and brightwork the same hue as the car body. The final effect of the AMG treatment, after all the spoilers, rocker moldings and air dams are in place, is a car that looks to have been dipped in a huge vat of rich lacquer.

AMG's pricey modifications, available in the U.S. through Beverly Hills Motoring Accessories, run all the way to exhaust headers and complete performance suspension packages. On the domestic front, though, the legal restrictions foster simpler cosmetic and suspension conversions like those performed by Cars & Concepts of Brighton, Michigan. For \$12,000 over the price of the car, Cars & Concepts will build you a Grand Touring Coupe out of a new Lincoln Continental Mark VII LSC coupe. With swoopy body panels, fancy wheels, gatorback tires and Koni shocks, America's favorite luxury GT does an incredible about-face into the ultimate hot-rod Lincoln.—C.G.



Cars & Concepts Lincoln is based on Mark VII LSC (top). AMG Benz started the luxury GT fad.

PROTECTION RACKET

The crunch (bam!) and grind (pow!) in pro sports (smack!) leads to (slam!) injury—also to the design of new gear to prevent it.

BY DENNIS ESKOW, Science/Technology Editor,
AND LARRY SHERMAN



PHOTOGRAPH BY FOCUS ON SPORTS

In the world of big-league sports, injury is the mother of invention. Take the polyurethane "goatees" that hang from the protective face masks of most major-league catchers and home plate umpires. It didn't exist until the fall of 1976, when then-Dodger catcher Steve Yeager was kneeling in the on-deck circle at the San Diego stadium. Teammate Bill Russell was at bat. Russell swung at a hard slider, breaking his bat into pieces. One of them went flying into Yeager's neck, tearing skin and injuring tendons. Yeager missed a month of baseball, and when he returned, the Dodgers issued him a makeshift goatee made of a leather remnant to protect the injured area.

Anyone old enough to recall the gimp knees of New York Jets quarterback Joe Namath will remember how his career was extended into the 1970s with the advent of a new knee brace. Last year, that very same device—the Lenox Hill Derotation Brace—was worn by every lineman, offensive and defensive, on the Cleveland Browns. In a business where one out of three players will injure his knee each season, the Browns boasted no knee injuries on their lines in 1985. Last year's experiment has become this year's standard equipment. Several National Football League teams are expected to go with the

Catcher Daryl Porter's neck is protected by a polyurethane "goatee." It was invented after an accident.

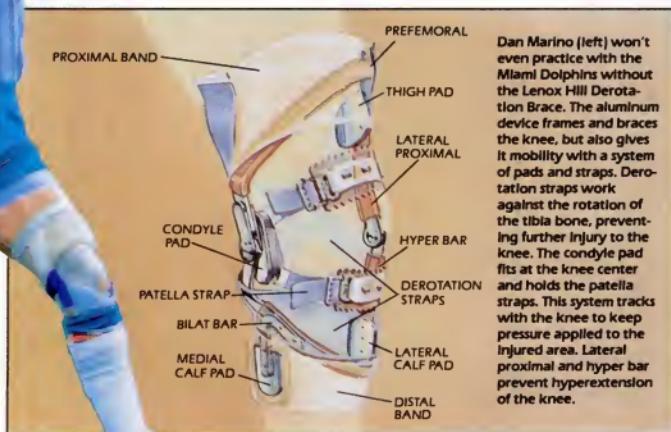


Lenox Hill brace this season.

"When you're young, you don't wear anything," says pro-soccer goalie Shep Messing. "But when you're older, you wear everything." Messing has recently bedecked himself with a dizzying array of equipment, he calls "the Shep Messing Support System." Laugh if you want to. He's wearing it with the New York Arrows today,

and it might be standard soon.

"As an indoor goalkeeper, the first thing you have to protect are your elbows," Messing says. He has added a metal disc to an ordinary hockey elbow pad to give his arms extra freedom of movement. He also has taken to wearing a mask after nursing a broken nose and cracked cheekbone. His first mask was a plastic full-face number that blocked his peripheral vision. As with



Dan Marino (left) won't even practice with the Miami Dolphins without the Lenox Hill Derotation Brace. The aluminum device frames and braces the knee, but also gives it mobility with a system of pads and straps. Derotation straps work against the rotation of the tibia bone, preventing further injury to the knee. The condyle pad fits at the knee center and holds the patella straps. This system tracks with the knee to keep pressure applied to the injured area. Lateral proximal and hyper bar prevent hyperextension of the knee.

New York Ranger goalie wears a birdcage mask that gives him peripheral vision. Early protection looked like a "death mask."

are lightweight, like batting gloves, but they are lined with thick Sorbethane rubber to take the shock of a slide. Will other clubs adopt the Schneider glove?

"If your guys have a problem with the mechanics of sliding, I think this piece of equipment is going to pay off," Schneider says.

The increasingly popular Lenox Hill brace is currently going through an update. The original is tried and true. But the updated model, expected to be used experimentally later this year, will be lighter weight, making it more desirable for runners and swimmers.

It is already light enough for Miami Dolphin quarterback Dan Marino, who doesn't even practice without one. Gerry Schwillie, trainer for the New Jersey Generals, swears by it and notes that the Generals' new quarterback, Jim Kelly, will report to camp for the first time this fall with his own brace.

Kelly injured his right knee in the closing minutes of a United States Football League game while playing for the Houston Gamblers last season.

"I was able to come back for the USFL playoffs wearing the Lenox Hill

around the front of the knee, allowing complete mobility.

A set of "derotation straps" works against sudden and unwanted movement of the injured area, preventing further damage. A condyle pad fits at the center of the knee, holding a set of patella straps in place. This part of the system tracks the knee as it moves, keeping pressure on the injured area. A system of metallic bars—lateral proximal and hyper bar—keeps the knee from becoming hyperextended, a condition that prevents an injured knee from bending. The Lenox Hill brace allows the athlete to bend his knee.

Given the success of the brace, one would imagine that its makers would be dashing off to build other sports protection devices. But Lenox Hill Vice President George Ganzekau says that won't happen. "We just do one thing right."

But a new knee brace is coming down the pike soon. Dodger trainer Bill Buhler, who fashioned the first goatee, is designing a combination knee brace and shin guard for catchers. "Catchers are most vulnerable on their left knee," Buhler notes. "Especially when they

PHOTO BY SPORTS ILLUSTRATED

many hockey goalies, Messing has tossed the full-face mask and taken up the new birdcage variety that lets you see in every direction. He also has experimented with a mask that hides most of his cheek, but gives him total peripheral vision by keeping open the area around his eyes.

One of professional hockey's greatest goalies brought the mask into prominence during a wild game in 1959. The late Jacques Plante was tending goal for the Montreal Canadiens when New York Ranger Andy Bathgate shot the puck right into his face. A dazed Plante stormed off and headed for the locker room of Madison Square Garden. When he emerged to play the following period, he was wearing a "death mask" with tiny eye holes and a nose hole. The metallic mask became refined over the following years, but the image of Plante and his frightful-looking mask will hover over hockey forever.

What are the new pieces of equipment for next year? Place your bets on the Herman Schneider sliding glove. Schneider is trainer for the Chicago White Sox baseball team, which boasts two very game, but unorthodox base-runners in Harold Baines and Rudy Law. When either of the two slides into a base, he has a tendency to come down hard on his hands.

Last season, Schneider rigged up a set of gloves for the two players. They



Soccer goalie Shep Messing is experimenting with a half-open mask and other devices.
Knee Brace," Kelly says. "I'm not going into a game anymore without a brace. That's my insurance policy."

The Lenox Hill device is the most sophisticated piece of protection in any game. Before it was created, knee braces were posterior, placing the framing of the brace in the back of the knee and keeping the athlete from running. The high-tech aluminum brace is anterior, meaning its solid framework goes

block a runner from scoring. It's still in the experimental stage."

This is the busiest time of year for pro sports. Baseball is under way, track and field is going outdoors, golf and tennis are in bloom.

If you look in on any of these events, watch the guy who sits at the end of the bench. He's the trainer. The man who this very minute is dreaming up a device you'll soon be using.

SPACE CITY

NASA has told its contractors that the Space Station concept they were developing has been thrown out. The new idea is revolutionary.

"Man learned to fly when he stopped thinking of an airplane as a mechanical bird and started thinking of it as a flying ship."—Charles Lindbergh

BY DENNIS ESKOW
Science/Technology Editor

In space, as on Earth, man is changing his way of thinking about how things fly. This year, the design of the Space Station has changed so radically that we're back to square one. NASA originally told the aerospace industry that it wanted a power tower design—a single Space Station structure that could be built up lengthwise from a central core orbiting the Earth. The big companies like Rockwell, Lockheed, McDonnell Douglas, Boeing and Grumman quickly came up with designs that would fulfill that requirement. But toward the end of 1985, NASA threw a curveball to the aerospace industry, scrapping the power tower idea in favor of a dual-keel design. Suddenly, we were thinking ship again.

"The dual keel is an ingenious concept, because it will let NASA build a virtual city in the sky," says Warren Reade, an engineer with the European Space Agency who is working on an ESA module for a 1995 launch to the American Space Station. "Having the structure built on the twin-keel principle means we'll be able to have better balance in the center of the Space Station and run more industrial operations."

The dual-keel design is a rectangular structure about 300 feet long by about 140 feet wide. A beam slightly longer than a football field crosses the twin trusses at about the midline. The original Space Station reference design was a 450-foot-long beam crossed near the top by a 200-foot beam. Industrial and scientific pods were to be fastened to the structure at the crossbeam.

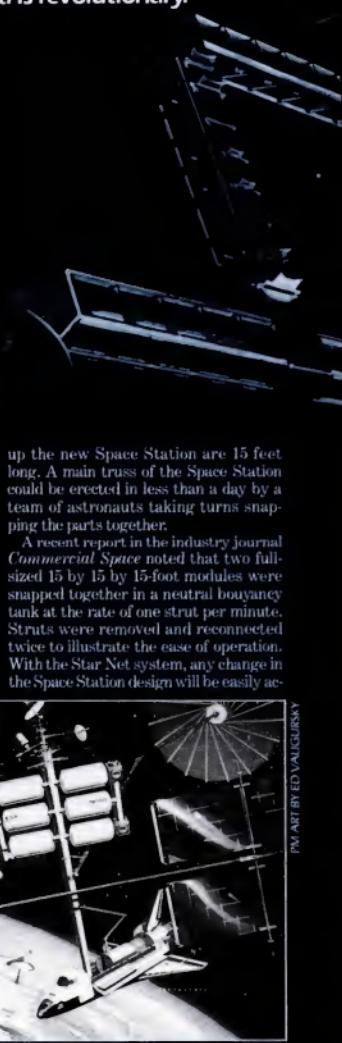
"Potential users complained that the original design didn't have enough absolutely stable space to conduct industrial operations such as crystal production," a NASA spokesman told us at a business-in-space conference. "If you wanted to make crystallized metals or pharmaceuticals, your pod has to be located at just about dead center of the Space Station." That limited the number of potential business operations—and the station is to be mostly business.

Placement of the live-in modules near the center of gravity in the new design will allow for almost five times the num-

ber of factories in the space city. And the dual keel is stiffer than the original power tower, so vibration will be reduced. The American aerospace community went back to the drawing boards last December to come up with new designs to meet NASA's latest vision.

While the change in design has shaken up the aerospace engineers, specifications for construction methods have become firm following successful experiments in orbit and in a water tank at McDonnell Douglas's Huntington Beach, California, facilities. The Star Net Division of Space Structures International Co. ran tests on Star Bay 1, an interlocking system of aluminum struts that can be snapped together without tools. During the first in-orbit experiment aboard the Space Shuttle last November, the media fondly dubbed the system NASA's Tinker Toy. But the experiment was far more significant. Star Net President Wendell R. Wendel declared that his company had proven large portions of the Space Station can be "erected easily by a single astronaut without tools."

The interlocking struts that will make



NASA's original design, called the power tower, was a single beam with the manufacturing units located off-center. It didn't allow room for enough factory pods.



NASA's dual-keel design Space Station will place factories at its center. They'll be mounted on trusses assembled in a matter of hours by a small number of astronauts. In addition to the factory city, the Space Station will have a geophysical observation post pointing toward Earth, and an astronomical observatory pointing toward deep space.

commodated. Star Net is a subcontractor to Lockheed, which would seem to give that aerospace giant a leading edge in the race for the final design work.

There are other improvements in the overall Space Station design. Industrial pods will be connectable at either end so that a figure-8 system of pod linkups could be built. That would provide more ways to add pods to the station and offer any user additional working volume.

A new system of external airlocks and tunnels would provide more ports for viewing outside the Space Station and allow traffic to flow between dozens of pods rather than two pods at a time, as was envisioned with the power tower.

Each individual module will be able to be twice as long in the new design, increasing by eight times the pressurized areas inside the modules, and thus providing more living space for men.

Since the dual-keel design allows the entire Space Station to stand vertically with respect to the Earth, scientific experimental units will be placed far from the industrial modules. A crossbeam of as-yet undetermined dimensions placed at the bottom of the Space Station will be pointed toward Earth. From that perch, geologists and meteorologists will be able to perform research. A second beam at the top of the dual keel will carry astronomical gear such as telescopes and interferometers to explore space without atmospheric interference. Scientists at both the top and bottom of the Space Station will be able to perform their experiments 24 hours a day.

At the center of the dual hull will be NASA's logistics center, a 16-man module

that controls traffic and computers aboard robotized pods of the station. A twin airlock at the tip of the logistics section will connect to a permanent Japanese logistics module and a series of other modules that will be snapped on, removed and replaced regularly during the Space Station's first 10 years of operation. Orbiting Maneuvering Vehicles will be launched from the lower portion of the dual keel to perform repair and other jobs near the Space Station. And Orbiting Transfer Vehicles will be launched from just below the center of the Space Station to carry satellites into orbits beyond the station's reach.

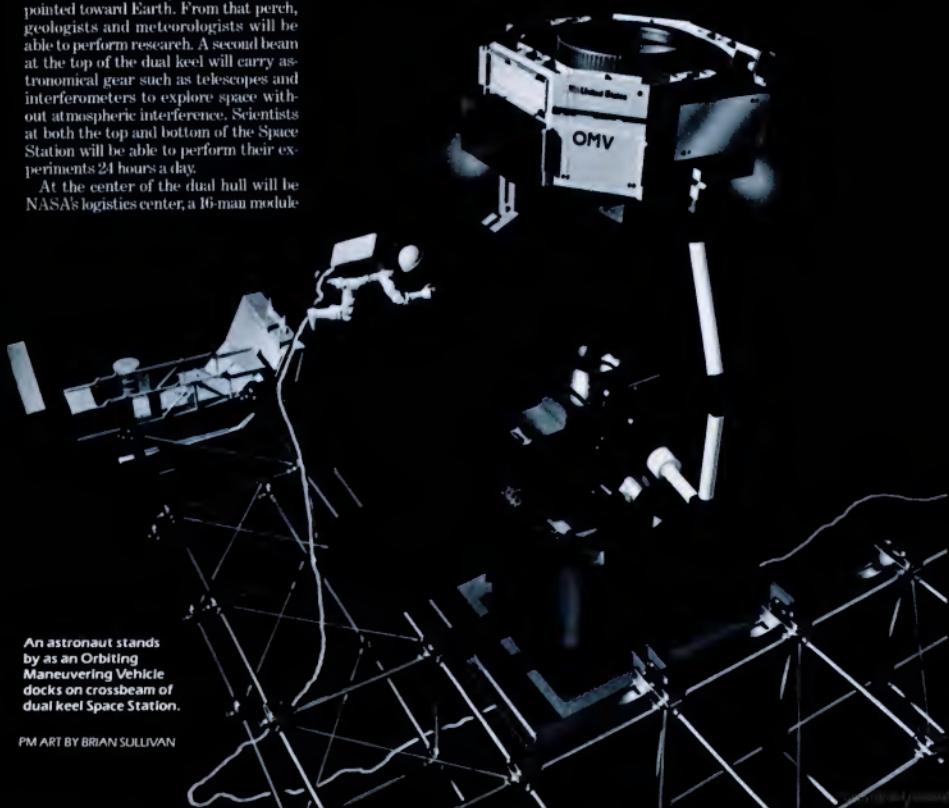
Despite the change in design, NASA says it will begin announcing contracts to build the station later this year. Construction may begin in the early 1990s. There already are a half-dozen potential customers to use the Space Station.

McDonnell Douglas has completed a half-dozen orbiting experiments with its pharmaceutical manufacturing unit and is ready to manufacture pure proteins

and medicines by 1992. International Space Corp. has won an agreement with NASA to fly a materials processing furnace on five or six Shuttle missions over the next five years. The cylindrical furnace would be used to form semiconductor crystals in a super-clean vacuum. Dust has plagued the semiconductor industry on Earth. A submicroscopic dust particle can scratch a crystal to the point of uselessness. In space, no dust will interfere with the process.

Japan wants to use the Space Station to launch several high-orbit vehicles and to perform electronics experiments. The Japanese industry ministry is already renting space on its pod.

The actual cost of building and launching the Space Station and its pods has not yet been finalized, but is believed to be approaching several hundred billion dollars. Still, NASA is confident that European and Japanese businesses will use so much of the extra area provided by the new twin-keel design that the Station can break even by the year 2000. **PM**



An astronaut stands by as an Orbiting Maneuvering Vehicle docks on crossbeam of dual-keel Space Station.

Private Place

This spacious arbor has operable louvers, built-in seating and an easy-to-build privacy screen.

BY WILLIAM AND DIANE WINANS

Sometimes you can take an old idea, change it around and come up with something new that despite all your effort isn't much of an improvement on the old approach. But sometimes with a little more effort, and maybe some luck thrown in, you can end up with something that is exciting. We think this arbor is a great example of the latter.

Designed by frequent contributor William Winans, this arbor features something we've never seen before: operable overhead louvers. Essentially, they work like horizontal venetian blinds. And the clever adjusting mechanism Bill came up with is certainly simple and surprisingly inexpensive to build. These louvers allow you to effectively block out—or let pass through—



The overhead louvers are adjustable—using two easy-to-build tools—so you can regulate the sunlight that passes through.

the amount of sunlight you want.

On warm summer days when the sun is beating down, you may well elect to bounce back a good deal of heat and light. Yet on cooler days in the spring and fall, you may well want the full effect of the sun's warmth.

But the louvers aren't the whole story. Also designed into the structure is a substantial privacy screen. It mimics the configuration of the louvers, while shielding your neighbor's view and letting the cool breezes pass

Design: William Winans

Color photos: Mark F. Molesky

Black and white photos: William Winans

Technical art: Dyck Flederus

Lumber: Wilmansized Pressure-Treated lumber,

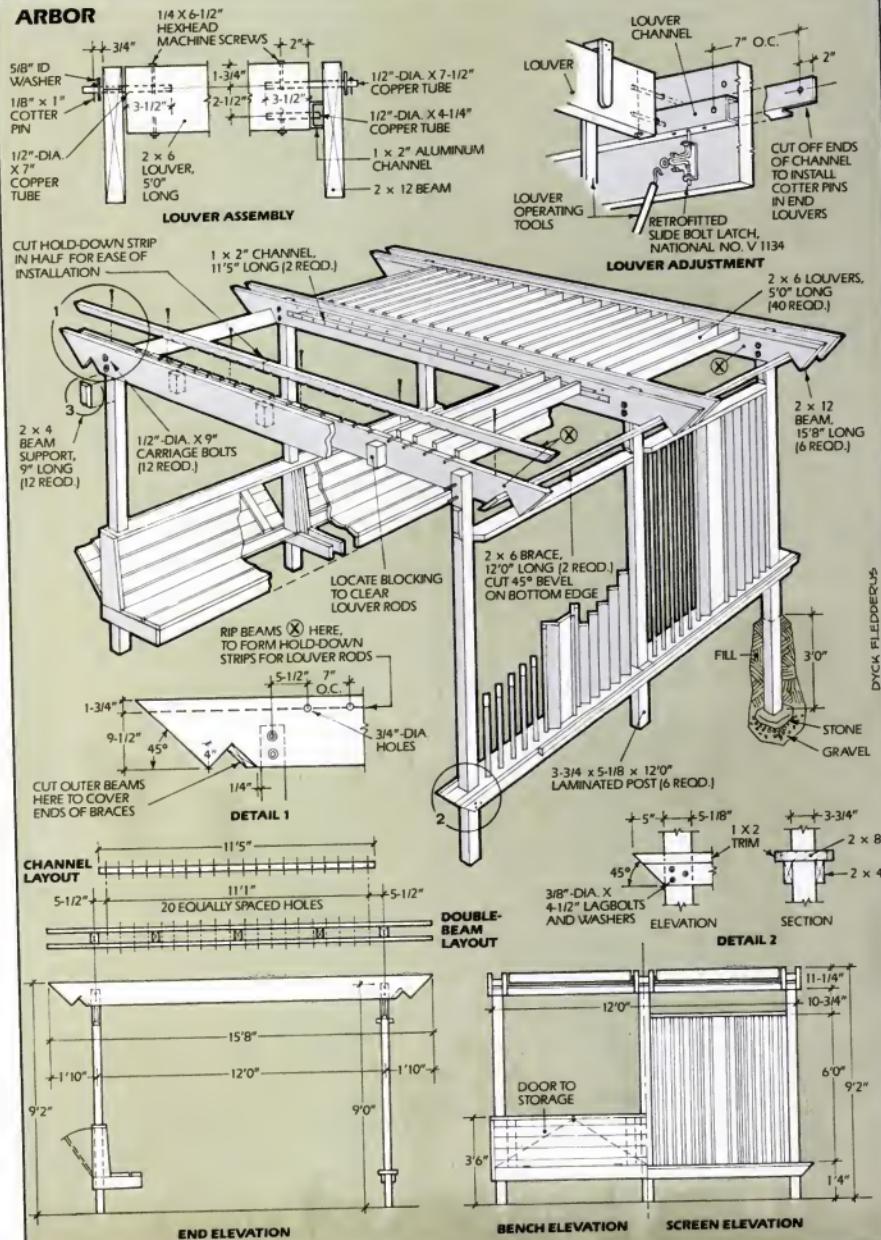
Koppers Co Inc., Pittsburgh, PA 15219

Light fixtures: Dimeco Products Inc., 123

South Newman St., Hackensack, NJ 07601



ARBOR



through. Add to this the built-in seating benches—which include storage for garden hose, small lawn care equipment and the tools to operate the louvers—and we hope you'll agree that this is something new that *does* work better. Following are directions for building this innovative structure.

—S.W.

Arbor layout

Begin by determining the position for the six posts. Follow the dimensions given in the drawing carefully. Because all the other parts in this structure are attached to the posts, if you make layout errors, you will have to change all the parts' dimensions to fit. Also bear in mind that we used Wolmanized factory-laminated posts, for their extra strength.

These posts measure $3\frac{3}{4} \times 5\frac{1}{8}$ in. and were positioned with the longer side aligned front to back. If you plan to use 4x4 or 6x6 posts, alter the layout to accommodate this change.

Set up batterboards and mason's string at the four corners of your layout



1 After posts are set in holes, plumb and brace them in place. Then begin seating benches by nailing back braces to post sides.

and check where the strings intersect for square. Then hang a line level on each length of string and check for level. (To see how this batterboard system works, consult our story *Stacked Deck*, page 117, April '86.) Using the strings as a guide, drive a stake into the ground at the precise location of each post.

Determine the lowest point of your grade by measuring down from the level string to the ground. Keep in mind that the seating benches are attached directly to the posts. If your grade falls off radically, then the benches will be uncomfortably low at one end or uncomfortably high at the other, or both. If you have a steep grade and want to duplicate this arbor precisely, then you'll have to level the area first.

Once you've established the low point, consult your local building department to determine the depth of the frost line in your area. Where we live, it's about 36 in. deep. So, beginning at the lowest point we excavated a 10-in.-dia. hole to a depth of 42 in. Then we filled the bottom 4 in. with gravel, placed a 2-in.-thick flat stone on top of the gravel, and placed the post on top of the stone. By using a 12-ft.-long post, this yielded 9 ft. of post above grade, which was our goal. If your frost line is deeper, use longer posts.

Excavate the remaining holes using the same system. Then set each post in its hole and backfill around it with soil.

1 After posts are set in holes, plumb and brace them in place. Then begin seating benches by nailing back braces to post sides.

SCREEN LAYOUT

BENCH DETAILS

BEAM SUPPORT DETAIL 3

LOUVER HOLE-BORING JIG

BEAM HOLE BORING JIG

OPERATING TOOLS

SECTION THROUGH STORAGE COMPARTMENT

SIDE ELEVATION

BENCH POST



2 Cut seat supports to size, then tack-nail to post sides directly under back braces. Maintain 5° angle for best seating comfort.

Measure frequently back to the string to make sure the posts are in the precise location. If you did your initial layout carefully, there should be enough adjustment in the holes to move the posts into perfect alignment.

Temporarily brace the posts with 2x4s tack-nailed 16 in. below the tops. Then measure 9 ft. above grade on the first post and attach one end of a mason's string to the mark. Wrap the string around the perimeter of the remaining posts. Level it with a line level, and mark the point where the string intersects each post. Remove the string and cut off each post at that point.

Louver beams

Remove the temporary braces used for cutting the tops and reuse them as diagonal braces for the posts. It is crucial that the posts be absolutely square and plumb before attaching the louver beams.

Cut all beams to the size and shape given in the drawing. Then bore louver rod holes through the beams that fall on the inside of the end posts, as shown in Detail 1. Next, rip $1\frac{1}{4}$ in. off the top of these two beams. This cut line should intersect the middle of the louver rod holes. Save the rippings because these form the hold-down strips for the louver rods that will be needed later. (Note: This step is necessary because once the louvers are installed, they are held captive in beam holes at both ends. By ripping off the strip, the louvers can be fitted into the holes in the middle beams and can simply rest on the ripped beams. When all louvers are in place, they are secured by attaching the hold-down strips.)

Lift all the beams into place and tack-nail them to the posts. Check for precise alignment, then attach with bolts, nuts and washers as shown. Add block between the beam members to stabilize each pair and to ensure uniform alignment. Then nail the supports (see Detail 3) to the posts under each beam.

Finally, cut to size and shape the 2x6 bracing boards that fall in the notch on the bottom edge of beams. Nail these in place but do not install the louvers yet.



3 Prebore clearance holes, then attach seat supports using lagbolts and washers. Tighten until washers begin to depress wood.



6 Join boards and cleats with screws to form storage compartment doors. Use $\frac{1}{2}$ -in.-thick spacers to maintain alignment.



8 Cut screen uprights to size and shape, then set rail on edge and attach uprights—at layout marks—using galvanized nails.



12 Secure tubing in ends of louver boards by installing bolt, washers and nut. Tighten bolt head with socket wrench.

It's better to wait until after the benches and screens are built. These add stability to the structure, which makes installing the louvers easier.

Seating benches

Cut the back braces and seat supports for the benches to the dimensions given on the drawing. Note that the two outside supports are longer than the middle ones because they cover the ends of the 2x6 stock used for the front seat support. Similarly, the outside back braces are wider than the ones that fall on the middle posts, because they were designed to cover the ends of the 2x6 seat-back boards. Because of this, you have to cut two small filler strips (marked with a "C" on the drawing) and nail these against the end posts to maintain the proper slant.

Once the back braces are nailed to



13 Cut aluminum louver channel to length. Then cut 2-in.-long notch in both ends to allow clearance for washers and cotter pins.

the posts, bolt the seat supports into place using lag screws and washers as shown in photo 3. Next, nail the front seat support in place and cover the entire bench framing with 2x6 and 2x10 stock, as shown in the drawing.

Next, measure the opening between the posts, then cut the 1x3 and 1x6 stock to size for the fold-down doors. Join the door slats to the cleats with galvanized nails or brass screws and then lay out the hinge position on the top of the back rail. Mortise one leaf of each hinge into the rail and the other into the support cleats on the inside surface of the doors. Before attaching the doors, cut 1x6 stock to length to create floorboards for both compartments. Bore several $\frac{1}{2}$ -in.-dia. holes in each for drainage. Toe-nail these into the posts.

Mount the hinges and check the doors



5 Locate hinge position for storage doors on rear support board. Then trace leaf outline and mortise board with sharp chisel.



6 To support door in open position, attach screw eye to door cleat, then attach chain with spring snap hook to inside of post.



7 Cut privacy screen rails to size from 2 x 8 stock. Then lay out position of all screen slats using a protractor or framing square.



10 Construct hole-boring jig as shown on drawing then clamp over ends of louver boards and bore holes for copper tubing.



11 Insert tubing into end holes. Then build second jig, clamp in place and bore vertical hole through louver and tubing.



14 Use jig for boring pivot holes in middle beams. Bore first hole, insert dowel pin for alignment, bore other holes through jig.



15 Install one set of louvers to stabilize structure, then install second set. Louvers must be pushed into middle beam holes first.

for fit. When satisfied, mount two chains with a snap hook to the inside of each compartment. Add a matching screw eye to the inside of each door, then snap the hook over the eye to support the door when it's open. Then fabricate the louver-operating tools and hang them in one compartment using large screwhooks.

Privacy screen

Begin by cutting the upper and lower support rails to size and shape. Any minor discrepancy between the dimensions we give and the actual dimension between your posts should be resolved in favor of the actual dimension.

Lay out the surface of the support rails to match the Screen Layout drawing. Note that all the screen parts are made of stock lumber except the middle panels. Each edge of the 2x10s must be

beveled 45° to accept the 2x6s that abut them. Once the layout is complete and the screen boards have been cut to size and shape, nail the boards to the rails using galvanized nails. Then toe-nail each assembly between the posts and add the trim boards around the bottom.

Louvers

Start by cutting all the louvers to size. Make sure your cuts are square and accurate because any minor error can cause the adjustment system to work poorly. Next, build the hole-boring jigs as shown. These will ensure straight and square holes for the tubing rods.

Bore the holes in the ends of all louvers first, then cut the copper tubing lengths and drive them into the holes. Be sure to shield the tubing ends with a scrap block of wood so the hammer blows will not bend over the copper.

Once all the tubing rods are in place, use the second jig to bore the bolt holes through the top edge of the louvers. Install the machine bolts, washers and nuts and tighten them in place. Then bore cotter pin holes in the ends of the tubing rods as shown in the drawing.

Next, cut the adjustment channel from 1 x 2-in. aluminum stock and drill the rod holes shown on the Channel Layout drawing. Establish the centerline of both channels and drill a $\frac{1}{2}$ -in.-dia. hole in the lower flange at this point. Drill the same size hole $1\frac{1}{2}$ in. away on both sides. These holes will accept the slide-bolt latch that is used for adjusting the louvers. Complete the aluminum channels by cutting a notch in each end as shown in photo 13.

Next, build the Beam Hole-Boring Jig. Before clamping it in place, run a string between the outside beams where the first rod hole is bored. Mark the spot where the middle beams fall under the string. Use this as your reference point. Clamp the jig to the beam then bore the holes. Once you've reached the end of the jig, move it down the beam. Slide a wood dowel into the first jig hole and the last beam hole to ensure precise alignment.

When you are finished boring the holes, temporarily attach the aluminum channels to the beams by wrapping wire around both. Then slide the louvers into the holes in the beams and the channels, resting the other end on the beams that were ripped to width before. Cover these rods with the hold-down strips then remove the wire supports from the channels. Install all washers and cotter pins and the louver assembly is complete.

To hold the louvers in the three different positions, we used a slide-bolt latch (National No. V1134) for each channel. To this stock item we added a light-duty spring to keep the slide bolt from dropping when installed in the vertical position. Then to hold the spring we welded a washer to the bolt just under the padlock loop. We also welded another washer to the outside of the loop to make gripping it without a hook tool easier.



Sound Construction

This spacious wall unit was designed to accommodate a generous sampling of today's sophisticated audio/video equipment.

BY ROSARIO CAPOTOSTO, Contributing Editor

Precious is the furniture piece that, through its unique design or imaginative use of materials, demands your attention. And rarer still is a piece that can completely overwhelm one's senses. With such a piece in mind, we went one step further and designed a unit that invites your participation.

The result is the magnificent wall-unit entertainment center shown—a furniture piece that you can see, feel, hear and live with actively.

Most of the audio/video cabinets we've seen are concerned merely with accommodating the electronic components. Our wall unit is designed carefully to



Wall unit design: Rosario Capolosio,
Steven Willton and Steven A. Booth
Color photo and black and white
design photo: JR Post
Black and white how-to photos: Rosario Capolosio
Technical artist: Eugene Thompson
Styling: Gabe Herrick
Electronics suppliers: See box on page 100

SOUND CONSTRUCTION

achieve optimum performance from the selected equipment. Speaker separation, isolating certain components and the logical placement and grouping of components were all determined only after thorough deliberation. For details on the arrangement of the electronic equipment, see the box on page 100.

An equal amount of thought went into making the components super-accessible. For example, you can gain access to the visual entertainment components—that is, the television and VCR—stored in the wall unit's center cabinet without opening the doors to the other cabinets. To operate the turntable, cassette deck and other audio components, open the right-side cabinet only. The left cabinet houses a bar with a plastic laminate surface. The lower portion of the three individual units provide spacious storage cabinets and drawers. But the one design element that really makes this wall unit function so well is the door hardware. Each of the 12 doors swing open and slide back to allow easy access to the components—thus creating a clean, uncluttered look. In fact, unlike most cabinets, this wall unit looks just as attractive with all the doors open as it does with the doors closed.

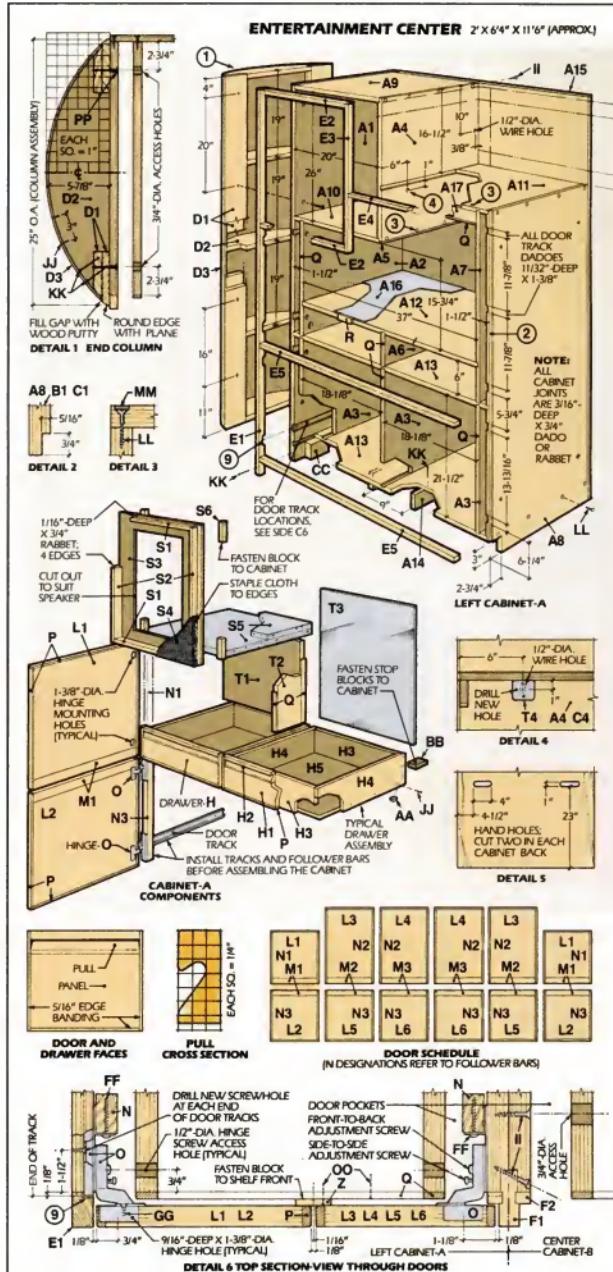
We built in several special features, too. For instance, the turntable platform has four adjustable feet to ensure a level surface. The record album storage drawers feature an adjustable rack with a tilt-forward panel that makes album selection easy. Small lights illuminate the bar area and the turntable. The VCR and video disc player shelves have slide-out platforms that allow easy access—a convenient feature if you own a top-loading VCR. And the large, mirrored display area provides space for framed pictures and art objects.

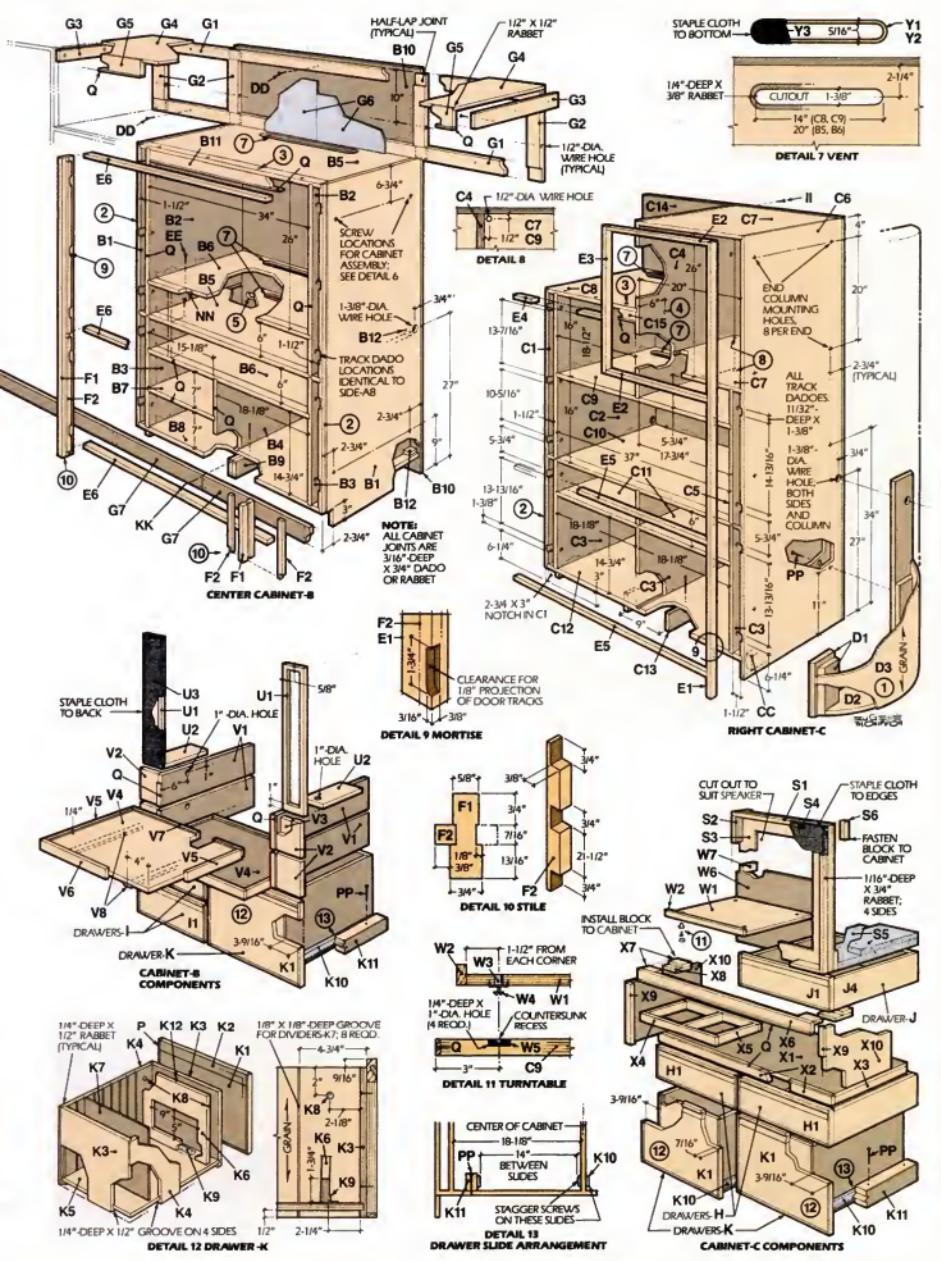
As a result of the time spent designing, altering and redesigning the original plan, the wall unit is both attractive and functional. But best of all, you can build it yourself.

Material selection

The wall unit is built primarily of $\frac{1}{2}$ - and $\frac{3}{4}$ -in. mahogany veneer plywood. Attractive ribbon-striped African mahogany plywood is used for highly visible parts, such as the doors, drawer faces and valances. Use less expensive lauan mahogany plywood for the shelves, drawers, dividers and other partially concealed surfaces. Solid mahogany is used as edge-banding and to make the continuous door and drawer pulls. It also forms the sharply contrasting black stiles and rails that outline and separate the pairs of doors.

Plywood is the single biggest expense, followed by the hardware. The hardware plays a key role in the wall unit's "user friendly" design. Most of





MATERIALS LIST—ENTERTAINMENT CENTER

Key	No.	Size and description (use)	Qty	Size and description (use)	Qty	Size and description (use)	Qty
		LEFT SIDE	4				
A1	1	3/4 x 23 1/2 x 76 1/2" lauan plywood (side)	2	7 1/8 x 1 1/2 x 56 1/2" mahogany (black stile)	4	3/4 x 3 1/2 x 3" pine (stop block)	8
A2	2	3/4 x 23 1/2 x 23 1/2" AMP (African mahogany plywood—interior)	2	3 1/2 x 2 1/2 x 16" pine (vertical frame)	2	1 1/2 x 3 1/2 x 15 1/2" AMP (door)	1
A3	3	3/4 x 21 1/2 x 23 1/2" lauan plywood (interior)	2	3 1/2 x 2 1/2 x 22 1/2" mahogany (cheat)	2	1/8 x 18" x 25 1/8" bar (mirror)	1
A4	4	3/4 x 21 1/2 x 23 1/2" AMP (speaker cabinet side)	2	1 1/2 x 24 7/8 x 24" AMP (top)	1	Roxter's Nothing lamp; model No. 7481	2
A5	5	1 1/8 x 9 1/2 x 23 1/2" mahogany (edge bend)	2	1 1/2 x 16 1/4 x 24" AMP (bottom)	2	2 1/2 x 4 1/2 x 24" lauan plywood (TV frame)	2
A6	6	3/4 x 6 1/2 x 23 1/2" lauan plywood (divider)	2	3 1/2 x 1 1/2 x 41 1/2" AMP (valance)	2	3/4 x 10 1/2 x 10 1/2" AMP (base)	2
A7	7	3/4 x 23 1/2 x 33 1/2" AMP (interior)	2	3 1/2 x 3 1/2 x 17 1/2" AMP (face)	2	speaker grille cloth	3
A8	8	3/4 x 23 1/2 x 23 1/2" lauan plywood (divider)	2	3 1/2 x 1 1/2 x 17" mahogany (pull)	2	4 1/4 x 6 1/2 x 22" lauan plywood (side)	4
A9	9	3/4 x 20 1/2 x 23 1/2" lauan plywood (top)	2	3 1/2 x 15 x 17" lauan plywood (front and back)	2	3 1/2 x 4 1/2 x 16" AMP (front)	4
A10	10	1 1/8 x 20 1/2 x 23 1/2" AMP (speaker cabinet bottom)	2	1 1/2 x 21 1/2 x 16" lauan plywood (side)	2	4 1/4 x 4 1/2 x 16" AMP (back)	4
A11	11	3/4 x 23 1/2 x 23 1/2" AMP (top)	2	1 1/2 x 21 1/2 x 16" lauan plywood (bottom)	2	3/4 x 17 x 22 1/2" lauan plywood (platform)	2
A12	12	3/4 x 23 1/2 x 37 1/2" lauan plywood (counter)	2	1 1/2 x 17" lauan plywood (front and back)	2	1/2 x 1 1/4 x 17" mahogany (platform side)	2
A13	13	3/4 x 23 1/2 x 41 1/2" lauan plywood (shelf end cabinet bottom)	2	1 1/2 x 17" lauan plywood (bottom)	2	1/2 x 1 1/4 x 23 1/2" mahogany (platform front)	2
A14	14	2 1/2 x 1 1/2 x 16" fir plywood (support)	4	1 1/2 x 17" lauan plywood (side)	2	pr. 18 1/2" record player slides	2
A15	15	2 1/2 x 1 1/2 x 16" fir plywood (back)	4	1 1/2 x 17" lauan plywood (bottom)	2	1/2 x 16 x 18 1/2" lauan plywood (platform)	1
A16	16	1 1/8 x 23 1/2 x 37 1/2" black plastic laminate	1	1 1/2 x 17" lauan plywood (bottom)	2	1/2 x 1 1/4 x 18 1/2" mahogany (platform front)	1
A17	17	3/4 x 21 1/2 x 18 1/2" AMP (valance)	1	1 1/2 x 17" lauan plywood (bottom)	2	1/2 x 1 1/4 x 18 1/2" mahogany (platform side)	1
		CENTER CABINET					
B1	2	3/4 x 23 1/2 x 23 1/2" lauan plywood (side)	2	3 1/2 x 45 1/2 x 14 1/2" AMP (face)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
B2	3	3/4 x 23 1/2 x 33 1/2" lauan plywood (interior)	2	3 1/2 x 15 1/2 x 14 1/2" mahogany (pull)	2	1/2 x 16 x 18 1/2" lauan plywood (front and back)	2
B3	4	3/4 x 21 1/2 x 23 1/2" lauan plywood (interior)	2	1 1/2 x 21 1/2 x 16" lauan plywood (side)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
B4	5	3/4 x 15 1/2 x 23 1/2" lauan plywood (divider)	1	1 1/2 x 16 1/2 x 21 1/2" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B5	6	3/4 x 23 1/2 x 36 1/2" lauan plywood (top)	1	1 1/2 x 16 1/2 x 21 1/2" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B6	7	3/4 x 15 1/2 x 36 1/2" lauan plywood (shelf)	1	1 1/2 x 12 1/2 x 16" lauan plywood (side)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B7	8	3/4 x 15 1/2 x 23 1/2" lauan plywood (sheet)	1	1 1/2 x 12 1/2 x 16" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B8	9	1 1/8 x 23 1/2 x 38 1/2" lauan plywood (bottom)	1	1 1/2 x 13 1/2 x 14" lauan plywood (front and back)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B9	10	3 x 3 1/2 x 11" fir plywood (support)	1	1 1/2 x 14 x 22" lauan plywood (side)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B10	11	3/4 x 23 1/2 x 36 1/2" lauan plywood (bottom)	1	1 1/2 x 13 1/2 x 23 1/2" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B11	12	2 1/2 x 21/4 x 16" AMP (valance)	1	1 1/2 x 13 1/2 x 23 1/2" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
B12	13	2 1/2 x 19 1/2 x 13" maple (door stop block)	1	1 1/2 x 13 1/2 x 23 1/2" lauan plywood (bottom)	1	1/2 x 1 1/4 x 17" mahogany (pull)	2
		RIGHT CABINET					
C1	1	3/4 x 23 1/2 x 23 1/2" lauan plywood (side)	2	3 1/2 x 19 1/2 x 13" maple (door stop block)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
C2	2	3/4 x 23 1/2 x 33 1/2" AMP (interior)	2	3 1/2 x 19 1/2 x 13" maple (door stop block)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
C3	3	3/4 x 21 1/2 x 23 1/2" lauan plywood (interior)	2	3 1/2 x 19 1/2 x 13" maple (door stop block)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
C4	4	3/4 x 23 1/2 x 33 1/2" AMP (speaker cabinet)	2	3 1/2 x 19 1/2 x 13" maple (door stop block)	2	1/2 x 1 1/4 x 17" mahogany (pull)	2
		DOORS—OVERALL DIMENSIONS					
C5	1	3/4 x 22 1/2 x 23 1/2" lauan plywood (interior)	1	L1 2 3/4 x 20 1/2 x 22 3/4" AMP (door)	1	1/2 x 1 1/4 x 23 1/2" mahogany (door alignment block)	AA
C6	2	3/4 x 23 1/2 x 76 1/2" lauan plywood (side)	2	L2 2 3/4 x 20 1/2 x 21 1/2" AMP (door)	2	1/2 x 9/16" nylon drawer slide tab	BB
C7	3	2 1/2 x 20 1/2 x 23 1/2" lauan plywood (speaker cabinet top)	2	L3 2 3/4 x 20 1/2 x 21 1/2" AMP (door)	2	1/2 x 9/16" nylon drawer slide stop block	CC
C8	4	3/4 x 21 1/2 x 23 1/2" AMP (top)	1	L4 2 3/4 x 19 1/2 x 32 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	DD
C9	5	3/4 x 23 1/2 x 37 1/2" AMP (shelf)	1	L5 2 3/4 x 19 1/2 x 32 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	EE
C10	6	3/4 x 23 1/2 x 41 1/2" lauan plywood (shelf)	1	L6 2 3/4 x 19 1/2 x 21 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	FF
C11	7	2 1/2 x 18 1/2 x 23 1/2" lauan plywood (bottom)	1	M1 4 1/2 x 19 1/2 x 21 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	GG
C12	8	3/4 x 21 1/2 x 23 1/2" lauan plywood (bottom)	1	M2 4 1/2 x 19 1/2 x 21 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	HH
C13	9	3 x 3 x 21 1/2" fir plywood (support)	1	M3 4 1/2 x 19 1/2 x 21 1/2" AMP (door)	1	1/2 x 9/16" nylon drawer slide stop block	II
C14	10	1 1/2 x 43 1/2 x 76 1/2" lauan plywood (back)	1	N1 2 3/4 x 13 1/2 x 22 1/2" oak (follower bar)	1	1/2 x 9/16" nylon drawer slide stop block	JJ
C15	11	3/4 x 21 1/2 x 18 1/2" AMP (valance)	2	N2 4 1/2 x 13 1/2 x 22 1/2" oak (follower bar)	2	1/2 x 9/16" nylon drawer slide stop block	KK
D1	12	3/4 x 21 1/2 x 18 1/2" AMP (bottom)	2	N3 4 1/2 x 13 1/2 x 22 1/2" oak (follower bar)	2	1/2 x 9/16" nylon drawer slide stop block	LL
D2	13	5/8 x 5/8 x 26" pine (rib)	2	O 14 pr Hinge-A-Door sliding track hinge	1	1/2 x 9/16" nylon drawer slide stop block	MM
D3	14	2 1/2 x 26 1/2 x 76" poplar plywood (skin)	1	P 2 1/2 x 13 1/2 x 34" mahogany edge band	1	1/2 x 9/16" nylon drawer slide stop block	NN
E1	15	2 1/2 x 26 1/2 x 76" mahogany (black trim)	1	Q 2 1/2 x 13 1/2 x 34" mahogany edge band	1	1/2 x 9/16" nylon drawer slide stop block	OO
E2	16	4 1/2 x 26 1/2 x 76" mahogany (black trim)	1	R 2 1/2 x 13 1/2 x 34" mahogany edge band	1	1/2 x 9/16" nylon drawer slide stop block	PP
E3	17	2 1/2 x 26 1/2 x 76" mahogany (black trim)	1	S 2 1/2 x 11 1/2 x 18 1/2" pine (speaker frame)	1	1/2 x 9/16" nylon drawer slide stop block	QQ
E4	18	2 1/2 x 19 1/2 x 21 1/2" mahogany (black trim)	2	S2 4 1/2 x 11 1/2 x 26" pine (speaker frame)	2	1/2 x 9/16" nylon drawer slide stop block	RR
E5	19	3/4 x 19 1/2 x 41 1/2" mahogany (black trim)	2	S3 2 1/2 x 10 x 26 lauan plywood (panel)	2	1/2 x 9/16" nylon drawer slide stop block	SS
E6	20	3/4 x 19 1/2 x 39 1/2" mahogany (black trim)	2	S4 2 speaker grille cloth	2	1/2 x 9/16" nylon drawer slide stop block	TT
F1	21	2 1/2 x 26 1/2 x 56 1/2" mahogany (black trim)	2	S5 .5 4 1 x 17 x 19" Styrofoam insulation	2	1/2 x 9/16" nylon drawer slide stop block	UU

the hardware can be found at any well-stocked hardware store. But, for those who can't find these items, the hardware is available through mail order from Armor Products, Box 445, East Northport, NY 11731. The cabinet doors operate on Hide-A-Door sliding track assembly (No. 78024): \$21 per pair postpaid; 14 pairs needed. The slide-out platforms work on 18 1/2-in. Grant record player slides, model A (No. 78026): \$12.75 per pair postpaid;

two pairs needed. Use 22-in. Grant full-extension slides for the record album storage drawers (No. 78027): \$42 per pair postpaid; three pairs needed. The seven accessory storage drawers glide on thin 1/8 x 5/16-in. nylon tabs that are installed in the cabinet and on the rear, bottom of each drawer. The adhesive-backed nylon slide tabs (No. 77517) come in 12-in.-long strips: \$2.50 postpaid for three strips.

The success of a project as complex

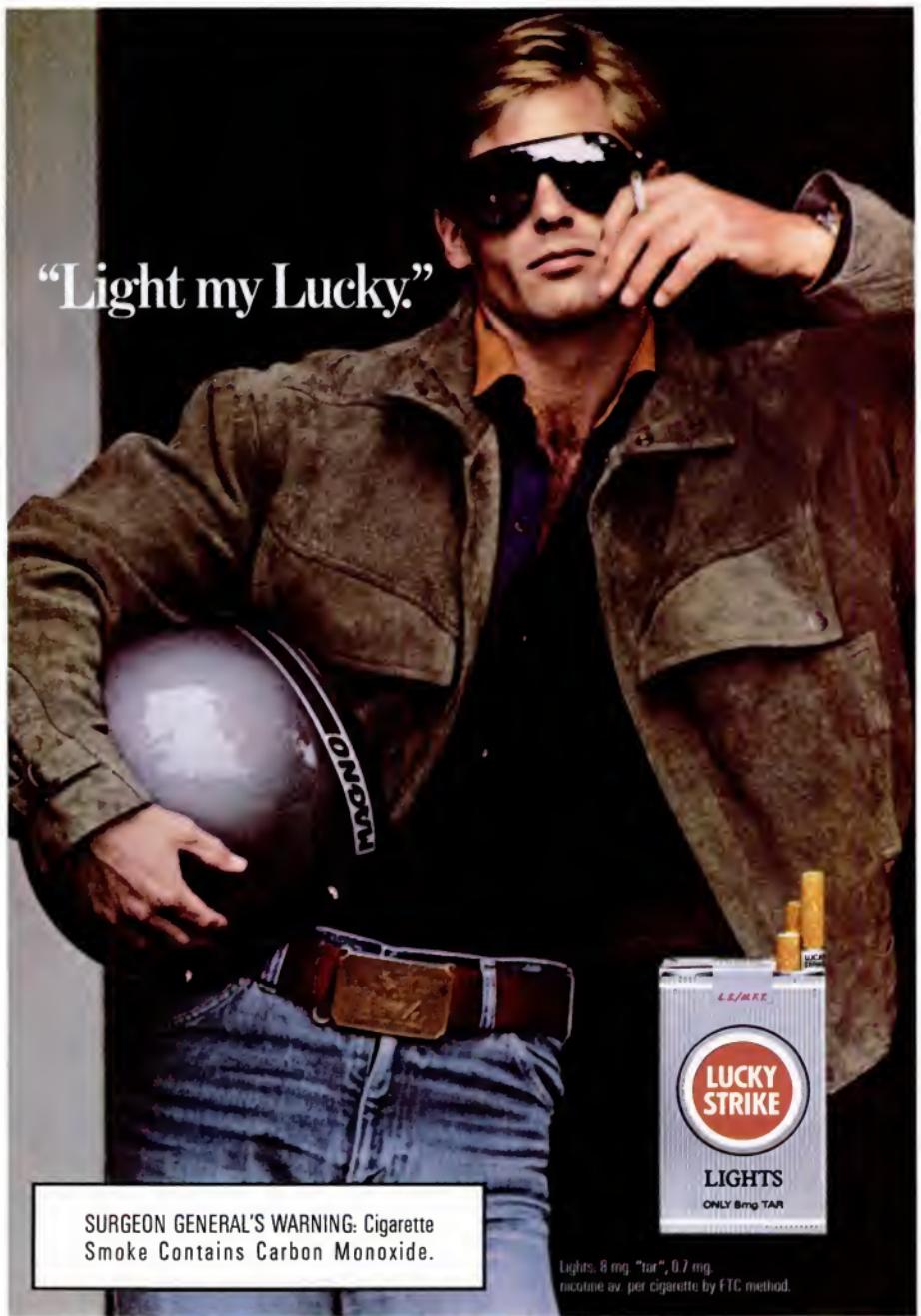
as this relies heavily on cutting the plywood members accurately. The best way to ensure uniformity and accuracy in measuring, marking and transferring dimensions is to use a shop-made graduated stick known as a story pole. Make the story pole from a straight piece of 1/2 x 1 1/2 x 80-in. pine. Then, lay a measuring tape along the pole's edge and use a knife to make small cut marks at the various required measurements. Identify each mark with the appropri-



1 Make a story pole from a straight length of 1/2 x 1 1/2-in.-wide pine. Mark the pole with various dimensions, then transfer marks to the workpiece using a knife.

2 Rout the dadoes with a 1/4-in.-wide straight bit and a straightedge guide. Note that identical-length wood blocks keep guide parallel to previously routed dado.

3 Install sliding door tracks flush with front edge of cabinet's sides. Then, screw a hardwood follower bar to the brackets (arrows) so tracks work in unison.



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4 Cabinet side at left has door tracks and follower bars installed. Panel on right will receive five tracks. Wall unit's four large doors require three sliding tracks each.

ate inch dimension. Mark the story pole with width and length dimensions of the cabinets' sides, backs, shelves, dividers and doors.

Cut the plywood parts for the three cabinets to size as given in the materials list. Apply $\frac{1}{4}$ in. x 2-in.-wide mahogany edging to the cabinet parts that require them. Attach the edging with $\frac{1}{4}$ -in.-dia. x 2-in. dowel pins and glue. Now use a router with a $\frac{3}{4}$ -in.-dia. straight bit to cut dadoes and rabbets.

Cabinet assembly

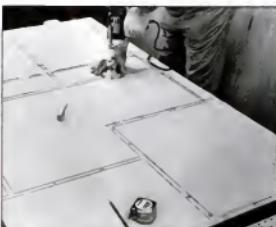
Dry-assemble the cabinets to permit boring screw holes. Assemble each cabinet on top of a 4x8 sheet of $\frac{1}{2}$ -in. lauan plywood. The plywood will be used as the cabinets' backs. Bore pilot holes, screw-shank clearance holes and then countersink for $\frac{1}{4}$ -in. No. 8 screws. Drive in a few screws to hold the cabinet together, position the assembly flush to the bottom edge and to one side of the $\frac{1}{2}$ -in. lauan plywood panel. Mark the plywood along the top and side of the cabinet to indicate the cut-off waste area. Also, outline the dividers and shelves on the inside surface of the back panel. Disassemble the cabinet and bore screw-pilot holes in the center of the outlines (photo 7).

Before starting the final assembly, rout a $\frac{7}{16}$ -in.-deep x $\frac{1}{4}$ -in.-wide rabbet in the front, outside edge of the four adjoining cabinet sides. These rabbets form a channel for the vertical black stiles that conceal the seams where the cabinets are screwed together. Bore the various screwdriver access holes and the holes for running the equipment power cords and speaker wires.

Next, rout the door track dadoes with a $\frac{3}{4}$ -in.-dia. straight bit and a



5 Airflow vents are necessary to prevent the electronic components from overheating. Bore two holes, then elevate the blade through shelf to cut out the waste.



7 Remove cabinet and bore screw-shank clearance holes, spaced 8 in. apart, in center of the outlines. Use a drill-guide attachment to ensure perpendicular holes.



9 Install the cabinets' sides last. But first, be certain that all the sliding door tracks, follower bars and hinge-mounting blocks are attached and working properly.



11 Mill door and drawer pulls on a table saw using tilted blade and angled guides. Raise blade $\frac{1}{16}$ in. after cutting all the pieces. Continue until blade projects $\frac{1}{2}$ in.



6 Dry-assemble the cabinets on top of their respective back panels. Then, bore screw holes. Before disassembly, outline the shelves and dividers onto back.



8 Assemble cabinets with slow-setting hide glue. Start with bottom and work toward top. Place wax paper under joints to shield against glue squeeze-out.



10 Square-up the cabinet and then clamp it to the back panel until the glue dries. The back, though, isn't attached until after the doors and drawers have been fitted.



12 Attach the self-closing, fully adjustable door hinges to the sliding tracks. The screwdriver access holes permit easy installation, adjustment and disassembly.

SOUND CONSTRUCTION

straightedge (photo 2). It's necessary to make two passes with the router to form the $1\frac{1}{2}$ -in.-deep x $1\frac{1}{8}$ -in.-wide dadoes. Take great care that the dadoes are exactly parallel, otherwise the doors won't slide smoothly or hang properly. Because of the weight of the doors, it's necessary to drill two additional screw-mounting holes in the track hardware. Drill and countersink

one hole about $1\frac{1}{2}$ in. from each end of every track. Screw the tracks into the dadoes. Then, screw $\frac{1}{4}$ x $1\frac{1}{8}$ -in.-wide wood strips, called follower bars, to each set of sliding tracks. The bars tie the tracks together so that the hardware will slide in unison. The hinges can be attached to the tracks after the cabinets are assembled, but the cast aluminum hinge mounting blocks must

be screwed to the tracks *before* assembly. Assemble the cabinets using slow-setting hide glue. Start with the cabinet bottom and work toward the top. After all the dividers and shelves are in place, attach the sides with glue and $1\frac{1}{8}$ -in. No. 12 screws (photo 9).

Now stand the units upright and screw them together temporarily to permit fitting the trimwork, doors and

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Electronics components vary in height, width and depth according to brand, model and age. You'll find plenty of room and flexibility in our entertainment center.

We've calculated dimensions to accommodate today's, yesterday's and even some of tomorrow's audio/video gear. For example, the TV cavity is much wider than most current tabletop TVs. When wide-screen High Definition TV arrives, you'll have plenty of space. For now, our cloth-covered spacers will fill the gap and let sound escape from side-firing TV loudspeakers.

Speaking of speakers, the spaces in the top corners of our center are sized to fit most models designed for bookshelf mounting—and even some smaller floor-standing units. But loudspeaker placement opens up a whole can of worms.

Height-wise, we're okay. Bookshelf speakers have good sound dispersion when placed just above ear level (when you're sitting). But horizontally, the stereo separation between the speakers might not be enough if you sit more than 12 feet from the unit. If so, position the speakers at the outer edge of each cavity (the center's rounded end columns provide 6 inches of clearance from any reflecting walls). Laying the speakers on their sides with the tweeters (treble drivers) outmost will help, too.

Installing speakers in an open cavity is subject to controversy. Audio purists would never do it—for very sound reasons. Reflections within the hollow space could distort the music reaching you. Vibrations reaching a nearby turntable might be picked up by the record stylus and fed back



Foam below speaker centers it in cavity for cutout in baffle board (not shown).



Leveling screws (4) in turntable panel are inset in rubber feet to dampen vibration.

through the system. This not only muddies the music, but strains your amplifier, too.

In the real world, though, people do place their loudspeakers inside resonance-inducing wall-unit cavities. We've designed some features to minimize the handicaps.

One is our grille-cloth-covered baffle. The plywood that surrounds the speaker on the same plane as its front-firing drivers will prevent any soundwaves from leaking back into the cavity and causing unwanted resonance. You may have to remove the speaker's original grille.

We recommend you use sheets of Styro-

foam to raise the speaker to center it in the baffle. This foam will absorb vibrations that might migrate to the turntable. Though not shown, you can pack insulation around the tops and sides, too. Obviously, our insulation and front baffling will impede the performance of speakers with back-, top- or side-firing cones (most of these are designed for open placement). In this case, forget the plywood baffle, and put insulation below the speaker only.

For extra protection from internal vibration, we've built-in some help for your turntable's suspension system. It's an independent panel supported by four screws that bear on rubber pads. The screws are adjustable, so you can level your turntable. Few record players have this feature, and we don't know of any entertainment center that does.—S.A.B.



Cloth (top) covers gaps for TV speakers. Tapes are far from harmful magnetism.



Internal brace keeps records upright, but also releases so you can read jackets.

ELECTRONICS COMPONENTS

State-of-the-art audio and video complements our entertainment center, seen on page 92. The center module houses Yamaha's 25-in. YM-950 stereo TV. Just below is the Marantz VR550HQ, a VHS VCR with hi-fi sound and High Quality picture circuitry. Kenwood's KSR-1000 satellite TV receiver completes the stack. The bottom-left space in our right module holds Yamaha's LV-X1 laser videodisc player. Above it, all our video and audio components. To the AV-One are a VHS videocassette and a synchronous *AudioSource*. The P4 automatic turntable, part of the Atelier Series from ADS, occupies the topmost slot. ADS Atelier components make up the entire stack at far right. From top to bottom, they're the A2 amplifier, T2 tuner, CDS Compact Disc player, and C3 cassette deck. Hidden behind black grille cloth (but seen above on this page with their own grilles removed) are Advent's Prodigy loudspeakers.—S.A.B.

drawers. If the floor is uneven, build a perfectly flat, level platform using 2x4s and particleboard.

Next, cut solid mahogany to make the black vertical stiles. Note that it's necessary to rout shallow mortises in the back edge of the stiles in order to clear the protruding tips on the sliding tracks (see drawing Detail 9).

Doors and drawers

Cut the doors and drawer faces from $\frac{3}{4}$ -in. African mahogany plywood. Next, mill the solid mahogany door and drawer pulls on a table saw (photo 11). Tilt the saw blade to 43° and elevate it $\frac{1}{8}$ in. Clamp a wood fence to the saw table $\frac{1}{2}$



13 Here's how to transfer hinge centers to the doors. Use a notched block to mark hinge centers on wood strip. Then, use strip to mark hinge locations on doors.



14 Screw the hinges to the mounting holes in the doors and then reattach the hinge to the sliding tracks. Adjust the hinges until the doors operate properly.



15 Drive 1-in. nails through drawer fronts so points protrude $\frac{1}{8}$ in. Press drawer face against points to make marks. Apply glue, realign marks and drive nails.

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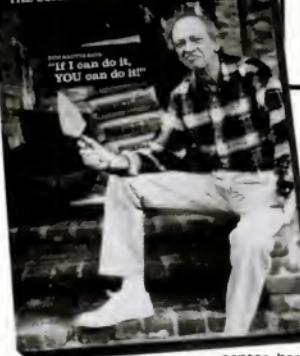
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SOUND CONSTRUCTION

in. away from the blade's highest point at an 85° angle to the back edge (infeed side) of the saw. Clamp another board parallel to the wood fence spaced 1 1/8-in. away. Now, lower the blade projection to $\frac{1}{16}$ in., start the saw and pass each workpiece over the blade. Continue to elevate the blade $\frac{1}{16}$ in. at a time until it projects $\frac{1}{2}$ in.

Attach the pulls to the doors and drawer faces with glue and $\frac{3}{4}$ -in. brads. Snip off the brads' heads for use as alignment pins. Glue and clamp the pulls in place using 3-way edging clamps. Now glue $\frac{5}{16}$ x $\frac{3}{4}$ -in. mahogany edge band to the remaining edges. Next, lay out the $1\frac{3}{8}$ -in.-dia. hinge-



16 This view of center cabinet shows VCR compartment located beneath TV shelf. Note that TV shelf supports are removable to permit feeding the power cords.



17 Install custom-cut panels to give the equipment a built-in look. Two components on left are separated by a platform to create two equal stacks of equipment.



18 The completed cabinets are screwed together and ready for finishing. A cardboard carton, the same size as the TV, is used when cutting and fitting the grilles.



19 Use a 2-in. strip of $\frac{1}{8}$ -in. poplar plywood to determine correct width of the plywood needed to cover end columns. Attach plywood with glue and 1-in. nails.

mounting holes in the doors. Here's how to locate the hinge centers. First, screw the hinges to the tracks (photo 12). Tape a $\frac{1}{2}$ x $\frac{3}{4}$ -in. stick, length to suit, to the cabinet alongside the hinges. Then, cut a $\frac{1}{16}$ -in. deep notch in a small wood block. Hold the block against the hinge to indicate its center. Use a knife to transfer the hinge's center to the wood stick (photo 13). Now use the stick as a story pole to mark the hinge centers on the doors.

Clamp a wood fence to the drill press table spaced $1\frac{1}{4}$ in. from the drill bit's center. Use this setup to bore hinge-mounting holes in the eight doors located in the center of the wall unit. Reposition the wood fence $\frac{1}{4}$ in. from the drill bit's center to bore holes in the four doors that are directly below the two speakers. Apply $\frac{1}{4}$ x $\frac{3}{4}$ -in. mahogany edge band to the exposed front edges of the cabinets with glue and $\frac{1}{2}$ -in. brads. Install the doors (photo 14).

Build all the drawers of $\frac{1}{8}$ -in. lauan plywood as shown in the drawing. Install full-extension slides on the record storage drawers. The remaining drawers all glide on simple nylon tabs. Install the drawer faces with glue and nails (photo 15). Now attach the cabinets' back panels with glue and screws.

Next, build the two rounded end columns. First, construct ribbed frames from 1x6 and 1x2 pine (photo 19). Then, glue and nail the $\frac{1}{8}$ -in. poplar plywood to the frame with 1-in. nails.

Final touches

Custom-build the various false front panels that give the electronic components a built-in look (photo 17). Also, make the TV and speaker grill frames. Wipe all surfaces with a tack cloth to remove sanding dust. Then, apply three coats of clear satin varnish. Sand lightly between coats with 240-grit abrasive paper. Paint the end columns and the contrasting stiles and rails with two coats of black latex semigloss paint.

Finally, set up the wall unit in your home, install the lights, mirrors and the electronic components and enjoy! **PM**

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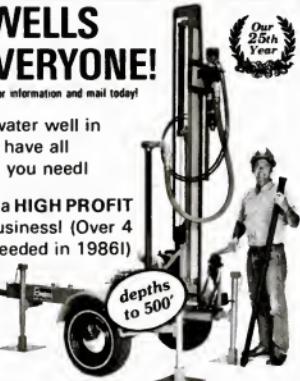
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ALL-AMERICAN GT

(Continued from page 80)

detailler John Guerriero. John brightened up our engine compartment by stripping the black factory paint from the intercooler pipes, sanding and buffing them smooth and then painting them with a spray can of VHT Metal Tint. This is a low-buck way of achieving a custom anodized look, and the shiny red finish has not been affected by engine heat.

Braided-steel hoses are a popular underhood dress-up item today with the street crowd. They look sharp but cost plenty. John achieved the same effect but at a much lower cost with Earl's Supply Tu-Braid steel braided slip-on hose covering. All the vacuum lines got the Spectre Industries Nyla Braid treatment, a slip-on nylon covering available in an assortment of colors. The hose coverings are cut to length and use Champ Bands, anodized aluminum finishing pieces that fit over hose clamps, or heat-shrink tubing to finish off vacuum lines.

The chrome alternator was supplied by Aries Chrome Accessories. John finished off the engine dress-up project by adding yellow sparkplug wires from Earl's Supply and a touch of pinstriping to the timing cover.

Cornering and handling

Next up for our T-Bird was some help in the cornering department. Stock Birds are an excellent compromise of handling and comfort, but the real cornering maven would gladly take a firmer ride in exchange for reduced body roll and better directional stability. We turned our car over to Jan Zuidijk, director of engineering for Koni America Inc. Koni tightened things up with a completely revised suspension system that includes 15 percent higher rate springs front and rear, 50 percent higher rate sway bars front and rear, harder bushings and externally adjustable low-pressure gas struts up front and low-pressure gas shocks in the rear. The new springs allowed the T-Bird to sit an inch lower in the rear and half an inch lower in the front. The complete package, developed by Koni for Bill Kolb, is marketed by Kolb for \$749.

Choice of rolling stock is a very important ingredient in the Euro look. Our nod went to 16-in. Gotti D55A wheels from Europcar, shod with 225/50VR16 Goodrich Comp T/A rubber.

Interior modifications were all that remained at this point. What we wanted was a more high-tech image for the car. A Beverly Hills Motoring Accessories Performance Timer was just the ticket to get the ball rolling. This \$130 dash-mounted multifunction marvel

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Our choice in radar detectors was the Fox Matchbox Remote—one of the smallest units on the market. Installed for us by Cruisin' Music, Westwood, NJ, the Matchbox uses a behind-the-grille weatherproof sensor and an in-dash-mounted control unit that takes up only 4 square inches. Cruisin' Music also took care of our sound system needs by installing a Blaupunkt SQR05 New York AM/FM/cassette unit.

The Blaupunkt setup, complete with stalk-mounted BEQ65 equalizer, provides a real light show in addition to high-voltage tunes. The system uses two BPA260 amplifiers for a total of 120 watts per channel.

Cruisin' installed Blaupunkt's System I speakers up front and System III speakers in the rear. Each system uses component speakers with separate tweeter, midrange and woofer working with an adjustable 3-way crossover network. The rear speakers have 8-in. woofers while the fronts use 6 1/2-in. units. The price tag on the system is \$1849.80 plus \$500 for installation.

With our project complete, the only thing left to do was to get some performance numbers to see if the package really worked. The clocks at Old Bridge Township Raceway Park in Elizabeth, New Jersey, showed that our AMG-style Bird chopped a full second off quarter-mile times compared to stock. The intercooled version turned a 15.683-second elapsed time with a terminal speed of 88.75 mph vs. the 16.637 seconds at 82.26 mph for the stock turbo model. Skidpad results were equally gratifying. With the new Koni suspension and 16-in. T/As, we managed to pull .81g (clockwise) and .83g (counterclockwise). In stock trim, our Bird generated only .80g.

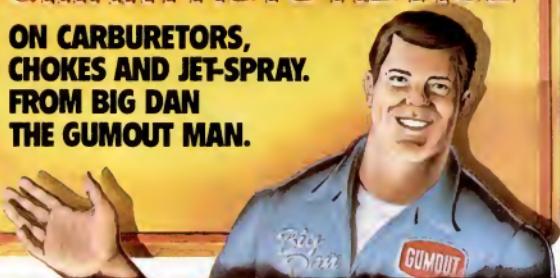
So with Euro-style looks, road holding and performance, our Americanized Thunderbird GT has arrived as a true flight of fancy.

EQUIPMENT AND SERVICE SUPPLIERS

- Aries Chrome Accessories, Ram Automotive Co., 201 Business Park Blvd., Columbia, SC 29203
- Beverly Hills Motoring Accessories, 200 South Robertson Blvd., Beverly Hills, CA 90211
- Blaupunkt Div., Robert Bosch Corp., 2800 South 25 Ave., Broadview, IL 60153
- Cruisin' Music, 51 Kinderkamack Rd., Westwood, NJ 07675
- Earl's Supply, 825 East Sepulveda, Carson, CA 90745
- Eurorep Inc., 2872 Walnut Ave., Tustin, CA 92680
- Fox Marketing, 4581 Taylorsville Rd., Dayton, OH 45424
- Faulkner Ford, Kolb-American Motorcars, Springfield, Ill., Route 303, Blauvelt, NY 10913
- B.F. Goodrich Co., 500 South Main St., Akron, OH 44318
- Koni America Inc., P.O. Box 40, Culpepper, VA 22701

SMART AUTO ADVICE

ON CARBURETORS, CHOKES AND JET-SPRAY. FROM BIG DAN THE GUMOUT MAN.



I've seen how dirty deposits can hurt a carburetor—and gum-up an engine. But what most folks don't know is how little it really takes. Or how fast those harmful deposits accumulate.

Experts say it takes dirt that's only one-thousandth of an inch thick to cripple a carburetor jet. And that thin layer of dirt can quickly become a dirtier, gummier mess.

A mess that'll settle in your carburetor. A mess that could make your car stall. Run rough. Start hard. A mess that'll creep into the PCV Valve, and cause rough idling. Acid corrosion. And heavier than normal oil and fuel consumption.

And because these dirty areas are so hard to see—and reach—most folks figure a costly professional cleaning is the only way to wipe it out.

But what I recommend is a really powerful jet spray cleaner. Jet-Spray Gumout® Carburetor & Choke Cleaner. It's preferred 3-to-1 over any competitor. And believe me, it's for a lot of good reasons.

It gets to the gum

and dirt. And cleans up your carburetor and choke like no other cleaner. With regular use, I've found you can keep your carburetor and choke virtually dirt-free—and that means saving gas, money, even the life of your engine.

Just spray Jet-Spray Gumout® on the outside of the carburetor.

On the carburetor linkage. On the automatic choke. And on the inside of the carburetor throat.

After that, spray it directly into the open end of the PCV Valve.

As it cleans your carburetor and linkage, it helps to stop that rough-running and stalling.

As it cleans the inside of the carburetor throat, it helps to stop that rough idling.

As it cleans the choke, it keeps it from sticking.

And finally, as it cleans your PCV Valve, your engine can start giving you a cleaner, better performance.

So for engine dirt that's quick-to-form and hard-to-reach, I recommend Jet-Spray Gumout® Carburetor & Choke Cleaner.



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America's Best-Selling Carburetor Cleaner

A Quality Product of the Pennzoil Company.





MITSUBISHI COLT VISTA

As a group, Colt Vista owners confessed their love for the Japanese car.

"Everyone gets a window," said an Air Force pilot from Hawaii. "We've got three children, and nobody ever wants to sit in the middle. They all want a window. Well, we recently took a 500-mile trip on the mainland and hardly heard a peep. The kids could even sleep with the rear seats laid flat."

A Tennessee credit manager told us that he coaches baseball and football in his spare time, "and I also have a family of four. Never have I owned a car that so perfectly fits my needs."

A Florida nurseryman had this to

say: "I felt this Japanese 7-passenger wagon was a better buy than the minivans we looked at. Roomy enough for the whole family, yet economical and easy to park and drive."

"Is this the Japanese Volvo?" asked a Minnesota business operator.

In nearly the same breath, they also let us know that they weren't exactly crazy about the Dodge and Plymouth dealers who sell and service the Colt

Vista. Dealer service ranked as the Colt Vista's No. 1 downer.

"This wagon cost \$3000 less than a comparably equipped small van, so it's an excellent buy," stated a New York water-treatment plant operator. "But there's been an annoying engine stumble ever since we took delivery. The dealer told us this hesitation is normal. Hah! Also, the air conditioner never has put out enough cold air. In the work the dealer's performed, he's been slow, poor at diagnosing problems, and gives us a lot of excuses about why things aren't corrected."

This came as a typical comment on dealer service. In all, a large 45.2 percent of the owners we surveyed rated dealer service fair to poor.

PM: *Although we haven't had any personal experience with dealer service, we can vouch for the half-hearted ventilation system. With seven people in this small wagon, the windows fog up quickly and the defroster takes forever. The top of the windshield is never clear on short trips.*

The Colt Vista itself, though, drew considerable praise. Most people bought this wagon for its roominess and

(Please turn to page 110)



Except for the high, chair-like seating, the interior looks like any other Asian import.



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Chevy 396 1954-58

Chevy 409 1954-58

Chevy 427 1954-58

Chevy 454 1954-58

Chevy 460 1954-58

Chevy 481 1954-58

Chevy 502 1954-58

Chevy 534 1954-58

Chevy 572 1954-58

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MITSUBISHI COLT VISTA

(Continued from page 106)

seating versatility. "The Colt Vista is the most space-efficient vehicle on the road," said a New York marketing manager. "It's comfortable, roomy, extremely flexible in its seating, has great

visibility, and the front-wheel drive is good in snow."

PM: *The owners we surveyed all had 1985 models, so none were equipped with the optional 4-wheel-drive system made available on '86 models. This "on-demand" system is a snap to use: You just push a button on top of the*

shift lever to go into or out of 4wd. It can be done at any speed, so long as the wheels are pointing straight ahead and you lift off the gas pedal momentarily.

Like similar 4wd systems, there is no center differential, and 4wd is not recommended on dry pavement. If you make a sharp turn on dry pavement

SUMMARY OF 1985 MITSUBISHI COLT VISTA WAGON OWNERS REPORTS*

Total miles driven	1,792,045	Specific dislikes:	Average	3.4	Number of vehicles owned:
		Not enough power	22.3%	Poor	0.0
Average miles per gallon:		Weak air conditioner	10.9	Rear seats	37.5%
In town	24.3	No complaints	9.7	Excellent	50.0
On the highway	29.3	Shifter/shift point	6.3	Good	12.0
Option choices:		problems	6.3	Average	0.5
Alloy wheels	75.6%	Nonremovable third	5.1	Poor	12.0
Power windows	73.2	seats			
Power door locks	72.2	What changes would you like?			
Custom trim package	49.3	More horsepower	21.8%	Had any mechanical trouble?	
Automatic transmission	42.4	No changes	16.2	No	58.9%
Power steering	22.0	Make rear seats		Yes	41.1
Air conditioning	19.5	removable	6.1	What type of trouble?	
4-wheel drive	2.9	Better fuel mileage	5.0	Air conditioner	14.5%
Why did you choose this car?		How much did you pay?		Engines stumble	14.5
Roominess	35.9%	Average	\$10,680	Oil leaks	14.5
Styling	28.8	Range	\$8700-\$13,100	Engines surge	9.6
Economy	28.8	Workmanship opinion:		Transaxle	8.4
7-passenger seating	26.8	Excellent	49.5%	Dealer repairs satisfactory?	
Good price	21.2	Good	43.8	No	57.8
Specific likes:		Average	5.7	Yes	42.2
Economy	41.6%	Poor	1.0	Dealer service opinion:	
Comfort	39.5	Comfort opinion:		Excellent	15.6%
Handling	34.2	Front seats		Good	39.3
Roominess	28.4	Excellent	62.7%	Fair	30.4
Styling	22.6	Good	33.8	Poor	14.8

*Percentages might not equal 100% due to rounding or insufficient data.

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with 4wd engaged, the drivetrain locks up and you can't move until 4wd is disengaged. (On snow or ice, some wheels just spin in sharp turns and everything is okay.) Compared to locking hubs or second shift levers of off-road 4wd vehicles, this is a minor inconvenience.

A Colorado bookkeeper wrote, "I like the fact that everyone sits up high, like in a van. The Colt Vista stands a bit taller than other vehicles, which I like. I also like all the little extras—the fold-down split third bench, the drink holders, twin gloveboxes, storage compartments under the front passenger seat and on the doors. You surely get a lot of standard equipment for the money!"

Praises, however, weren't totally unrestrained. Among quibbles, the loudest had to do with engine performance and horsepower. Just over 22 percent of our respondents, most of them with automatic transaxles, felt the 2-liter Silent Shaft one Four ought to deliver more than its 88 hp. "A bigger, stronger engine," said a Georgia writer, "would be the icing on the cake."

PM: With only one or two passengers aboard, the Vista has the same sprightly performance as most front-drive imports—peppy, but it's no dragster. With a full load of six or seven people and their gear, you often have to shift down into FOURTH or even THIRD to keep up with traffic, especially in hill country. As with most small imports, there's a noticeable performance tradeoff in everyday driving for the convenience of an automatic transmission.

A number of people also mentioned engine surge and the carburetor stumble cited above—glitches that have plagued the Colt Vista since its introduction in 1984.

Handling

As for handling, most drivers like the wagon's maneuverability, but a few said the suspension lacked poise. "Spongy ride; handling in corners feels top-heavy," remarked a Tennessee designer. And a New York military man pointed out that "on windy days, I feel some loss of steering control."

PM: This is true of any vehicle with a big van-like silhouette—it has a high center of gravity, so it's a bit tippy in tight turns, and it presents a big target for sidewinds to push around.

Seating didn't suit everyone, either. No one complained of cramped legroom, but several people cited a lack of lumbar support in the front buckets plus not enough leg support from the seat bottoms. And a New York police officer told us to be realistic about Colt Vista's seating capacity. "This is a great family car," he said, "but only for four adults and two or three children."

(Please turn to page 112)

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THE BETTER HOME



How To Replace A Sliding GLASS DOOR

It wasn't so long ago that a sliding glass door, or patio door as many manufacturers call them, was a new idea. They were the darlings of the remodeling trade and quickly became a frequent amenity of any kitchen redo or room addition. Their list of attributes seemed almost endless: Allow more

BY STEVEN WILLSON
AND WADE HOYT
Illustrations by George Retseck

natural light into the house, make access to the outside—particularly onto an outdoor deck—easier, and perhaps

most important, give an older home a contemporary look.

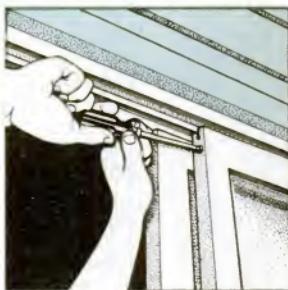
They were so successful that new home builders quickly adopted them as standard equipment, on both low-budget and high-ticket homes. Unfortunately, not all these doors were high-quality units and not all were installed



1 Begin by removing fixed door panel from old sliding unit. Usually, it's held by brackets screwed to the door and jamb.



2 Loosen screw that holds plastic alignment bracket on bottom corner of fixed door. Slide bracket away from sill track.



3 Next, loosen the alignment bracket on the top corner of the fixed door and pull bracket down. Door should now be free.

in the most sensible location. Both of these shortcomings were present in the house we chose for this installation.

The existing aluminum door was poorly installed and as a result worked poorly. But the primary complaint was that the door faced directly south and was positioned in the main dining area. During the summer months the room was uncomfortably hot and the drapes that covered the doors not only restricted air flow, but also were fighting a losing battle with three active young children.

The replacement choice solved these problems: A Pella 6-ft. wood and aluminum-clad sliding door. This unit is very well made and it features removable glass panes on the inside of both doors. This space, between the inner and outer glazing, was designed to accommodate either the manufacturer's venetian blinds or preassembled wood mutins to give the door a traditional look. While the unit is expensive, running over \$1000 with tax included, it did solve the homeowner's problems well, was easy to install and operated beautifully. If you plan to install a different unit, the basic directions that follow will apply in nearly every way.

Before you begin

One of the most important considerations is the simplest—namely measuring your existing door. You will want to get the closest match possible so you won't have to make structural changes in the house wall. Measure the height and width of the door and draw a sketch of the way it is shaped before you go shopping for a new door. This should give your local dealer all the necessary information.



4 Grip fixed panel with both hands and lift up into top track until bottom clears lip on lower track. Pull out door bottom.

Do keep in mind that your new door should always be smaller than your existing door because it's easier to close in a wall opening than it is to increase it. The latter requires removing the existing header and installing a new one to carry the additional weight.

Removing the old door

Begin by removing the casing boards that trim the inside of the door. Be careful when prying these away from the wall because you may be able to use them again on the new door.

Next, remove the screen door—if you have one—and begin removing the fixed panel on the slider. These are always joined to a side jamb with some type of bracket, usually one that clips over a lip on the jamb and is screwed to the stile of the door. On this door there were three such clips. Once these are removed, go to the opposite door edge and loosen the upper and lower align-

ment brackets as shown in drawings 2 and 3. These serve to keep the outboard end of the fixed door stable.

When these brackets are loosened, slide the door to one side, enough to grip the edge, then lift the door up so the top slides completely into the upper channel. This will free the bottom edge of the door so that it can be pulled away from the bottom track. Lower the door away from the track and set it aside.

Follow the same basic procedure to remove the sliding door: Loosen the roller wheels at the bottom corners of the door. Then lift up the door, pull out the bottom, lower the door and set it aside. At this point the door jamb assembly should be all that's left in the rough opening.

Depending on how the original frame was installed, the exterior trim may or may not cover a flange that surrounds the jambs. In this case, the old door had no such flange. It was simply attached with screws through the jambs to the jack studs on either side of the opening and to the header and the house floor. If you have a flange door, then the exterior trim must be removed first to get at the flange nails that hold the door to the house. Remove the screws or the flange nails and set the frame aside.

Preparing the opening

Once the opening is clear, check the header and floor for level, the jack studs for plumb and the corners for square. It is crucial that all these elements are true. Otherwise, the door will be difficult to install and may well operate poorly in the future.

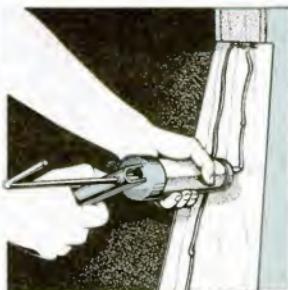
On this job we were fortunate: The opening was in good shape. If yours isn't, then you'll have to shim out the



5 Once both doors and the door frame are removed from the opening, check corners of rough opening for square.



6 Remove old caulk or other sealant from sill, then check for level. If sill is not level, new door must be shimmed to level.



7 Apply two heavy beads of caulk to sill to prevent air and moisture penetration after new door is installed.

various members until everything is right. Generally, this is best accomplished by leveling the floor shims first, then plumbing the stud shims and leveling the ones on the header. Cedar shingles and $\frac{1}{4}$ -in.-thick plywood strips are good for this job. The shims should be added to both sides equally so the door remains centered in the opening.

Assembling the new door

Depending on the manufacturer—and the way your supplier sells the door—the fixed panel may or may not come attached to the door frame. On this job the fixed door was already in place. But many other doors come with the door separate and the frame (jambs and sill)

unassembled as well. Because joining these parts is different depending on the manufacturer, be sure to follow the assembly directions carefully.

(Note: Unless the manufacturer recommends something to the contrary, it's a good idea to install the fixed panel before installing the frame. With the panel in place, the frame will be more rigid and therefore easier to handle. And, the fixed panel will serve to keep the whole assembly square, which makes the installation much easier.)

After the frame is assembled, apply two heavy beads of silicone caulk to the area of the floor that will be covered by the door. This will keep moisture, insects and air infiltration from coming in under the new door.

Next, get some help so there's a person on each end of the frame and lift it into place. Make sure to keep the assembly at least 6 inches off the caulk until you have pushed the frame into the opening. Once the new flange is bearing on the outside of the sheathing, lower the frame sill into the caulk and push the top in against the header. If you simply slide the unit into place, bottom first, the caulk will be scraped from the floor and the seal will be destroyed. Have your helper hold the assembly while you check the edges of the jambs

for plumb, level and square. Once satisfied, attach the door to the house wall by driving $2\frac{1}{2}$ -in.-long roofing nails through the flange and into the studs and header that surround the frame.

Installing the sliding door

Again, depending on the brand of door, the sliding panel may be installed and adjusted differently. In this case, the door was simply lifted up into the top track, pushed in at the bottom, then lowered onto the rib that acts as a guide for the built-in rollers at the bottom of the door. Read the directions for your brand carefully before proceeding.

Next, install the door handle, catch and lock mechanism on the sliding door and the strike plate in the jamb. At this point, roll the door back and forth and check how it meets the jamb. For the door to roll properly, for the catch and lock to work and for the weatherstripping to be effective, the door stile must be absolutely parallel to the jamb. If it isn't then the rollers at the bottom of the door must be adjusted.

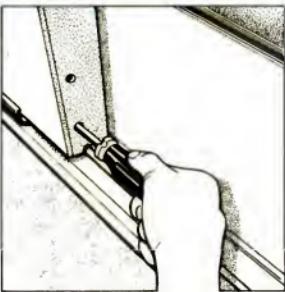
Next, install the trim around the outside of the jambs. In this case, we used 1 x 4 pine boards ripped to fit between the jambs and the siding. This was an easy "fix" and it closely matched the existing trim on the house. If you have different trim, for instance brick molding or 1 x 6s, then you'll either have to fill in some siding, or cut some more away until the space is the right size for the stock that matches the rest of your house. In any case, keep in mind that the trim should be nailed directly on the sheathing, not onto the siding. Once the boards are installed, caulk around the perimeter of each and fill the casing nail holes with wood putty.



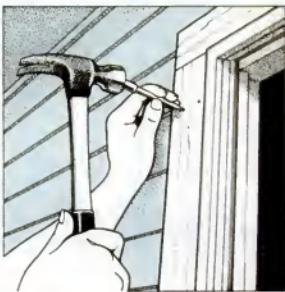
8 Lift new door frame into opening so sill comes down flat on caulk. Push top against wall. Don't slide bottom over caulk.



9 Check door frame for square, plumb and level. Attach by nailing through perimeter flange with galvanized roofing nails.



10 Install sliding door, then adjust rollers at bottom corners through access holes. Door must slide smoothly, hit jamb flush.



11 Cover perimeter flange with wood trim that fits between new door jambs and siding. Set and fill casing nailheads.

Trimming the Inside of the door

Before applying the interior trim boards, make sure that you fill the void between the new door jambs and the studs on either side with insulation. You can either slide in small amounts of fiberglass insulation or use a foam type as we did.

If you opt for the fiberglass, be careful not to compress it too much because this drastically reduces its effectiveness. Generally speaking, the foam insulation works better and quicker. It's available in spray cans at hardware stores, lumberyards and home centers. To use it, simply turn the spray can upside down and squeeze the nozzle. The foam will come out through an extension tube.

Some foams expand over twice their volume once they are in the cavity. If you fill the whole space when the foam



12 Working from inside, install insulation around perimeter of new door frame. We sprayed in aerosol foam insulation.

is wet, it will continue to expand and you'll have to cut the excess away later when it's dry. So, be sure to read the product's label directions.

Extension Jambs

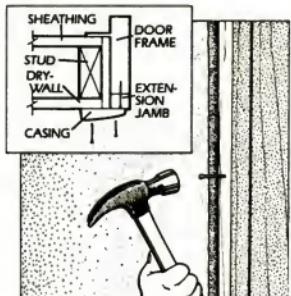
For casing trim to look right around any opening, the inside edge of your jambs must align perfectly with the surface of your room wall. Because of this many doors—and windows for that matter—have jambs that are slightly narrower than what's required. The idea here is that the manufacturer has no way of knowing what your wall finish is—drywall, lath and plaster, paneling and so forth. Because all these can vary in thickness, jambs are designed to receive another strip of wood to bring them out flush with the wall. These are called extension jambs.

To install them, simply measure the distance from the edge of the jamb to the wall surface and rip the extension jambs to match. Then nail them over the standard jambs. Once these are in place, apply the casing boards.

Finishing up

Install the screen door with its latch, lock, handle and strike plate and adjust its rollers so it closes against the jamb tightly. On the door we installed, the screen was designed to be retractable. It had a spring mounted along its top edge that pulled the door closed after it was released.

Another feature of this door, as mentioned before, was a venetian blind assembly installed between the double glazing on both door panels. To install them, all that's required is removing the inside glass panels on both doors, hanging the blinds inside and then attaching a small control knob in the lower right-hand corner. The glass panels that cover the blinds have a hole bored through that provides access to the control from inside the room.



13 Nail extension jambs to door jambs so frame is flush with wall surface. Set and fill nail holes, then nail on casing boards.



14 Inside and outside door pulls are attached with same two machine screws. Screws slide through prebored holes.



Front-end styling features a generic pop-up headlight nose and air dam plus complex aluminum alloy wheels. It's inoffensive and attractive.

'86 TOYOTA SUPRA

Toyota's sports car finally breaks free of the Celica mold.

BY STEVE PARKER, West Coast Editor

I think I've chosen the right profession, I thought and smiled as the main straight came into view and the speedometer on the new Toyota Supra climbed easily toward 130 mph. A great pleasure in life is being one of the first to test a high-performance vehicle, and this road-racing course in Hamamatsu, Japan (in the countryside about 120 miles south of Tokyo), was the perfect place to experience an extraordinary new automobile.

Toyota enters the major leagues of sports cars with this all-new-from-the-ground-up Supra, an expensive plaything with a 3-liter 200-hp in-line Six, double-wishbone suspension front and rear, and Goodyear Eagle gatorback VR-rated tires.

Four years in the making (with some advice from their English friends at Lo-

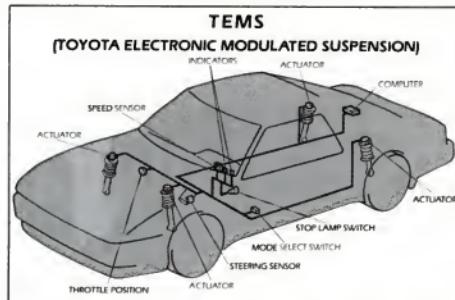
tus), this Supra is the third version of the car, the first appearing in 1979 as basically a stretched Celica with a 2.8-liter 6-cylinder engine replacing the standard Four. In 1982, the Celica Supra underwent a major transformation and became a fine-handling, albeit radi-

cal-looking, road car. Now, the Supra undergoes another incarnation, adding a 3-liter engine and dropping the Celica name. With this car, Toyota launches a frontal assault on some of the great road cars of the world, including Corvette, Porsche 944 and Nissan 300ZX.

Total plans to sell some 50,000 Supras this year in the U.S., with a base price of \$18,000 to \$20,000.

In exterior design, the Supra appears at first glance to be a combination of traditional Supra design, some Mitsubishi Starion, and more than a small measure of Mazda RX-7. Color-coordinated front and rear bumpers add a flowing touch to a somewhat bulky lower half. A large "B" pillar and sharply slanted front windshield combine to give the impression of a small, sporty cockpit.

(Please turn to page 119)



"Smart" suspension is similar to the system available on the 1985-'86 Crestida. The sport setting reduces lean, squat and dive.

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Pegasus A 7-ft. diameter hovercraft, which floats 10 inches off the ground. It's built from plywood and is powered by a 3.5 hp engine that runs nearly 3 hours on a gallon of gas. Plans come complete with drawings and a 32-page photo-illustrated instruction booklet. Great for weekend sports and leisure. (PL-1800-\$9.95)



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'86 TOYOTA SUPRA

(Continued from page 117)

though front passenger room is virtually unchanged. A removable top is also available on the Supra, and in spite of the hassle required to remove and replace it, it's bound to be popular.

The car is 569 pounds heavier than the previous model. Heaviest are those models with detachable roofs; they need more rigidity designed into the body. Engineering Chief Akihiro Wada



Sleek fastback lines reflect earlier Toyota themes and give a drag coefficient of 0.33.

points out that while increasing the weight was "certainly not a design goal, the larger engine required a heavier transmission and body."

The 24-valve, 2954-cc in-line Six hums along in perfect harmony (Toyota says a V6 generates too much vibration for their liking). The new fuel-injection system has two "V-nozzle" injectors

(Please turn to page 120)

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'86 TOYOTA SUPRA

(Continued from page 119)

per cylinder, in part accounting for a 24 percent increase in horsepower. Look for 24/20 highway/city mileage.

Toyota's last 4-wheel independent double-wishbone suspension on a production car was found on the 1967 2000 GT model. The use of aluminum upper A-arms on the front end is said to reduce front tire wear and improve handling and steering feel. Chief Engineer Wada told me when he designed the suspension, "I was careful to keep it as comfortable as possible. I was building a sports car, not a race car, and needed a supple yet rigid suspension."

The transmissions offered on the Supra are a 5-speed manual and a 4-speed automatic with overdrive. The clutch has been beefed up for the 3-liter engine and the automatic features electronic overdrive control (ECT).

Acceleration is smooth and powerful. The transmission and engine are well matched (gear ratios remain the same as 1985). Steering gets a bit light at



Interior provides traditional analog gauges and multi-adjustable power seats up front.

speeds you might never hit, but after a few laps I found the slight oversteer easy to control. Braking was likewise more than acceptable for any street occurrence. The Toyota Electronic Modulated Suspension (TEMS) system provides a noticeable firming of suspension feel at speeds above 50 mph.

Inside, the large speedo and tach are right where they belong—in front of the driver. Water temp, fuel level, oil pressure and voltage are reported with dispatch, in analog form. The Fujitsu radio/tape system is a winner.

Seating is superb, at least in front. Power lumbar and side supports keep the driver fitted snugly and leather upholstery is available.

If you order the Sports Package, you can impress your neighbors with the TEMS suspension, headlamp washers and limited-slip differential. But the base Supra—which comes with more standard equipment than cars costing much more but with lower performance—is impressive enough.



Acura lineup consists of the V6 Legend sedan (left) and the 4-cylinder Integra hatchback (available with 3 or 5 doors).

MID-YEAR BUMPER CROP

PM drives the '86½ models, plus a few early-bird '87s.

Honda has started a new network of 150 dealers to sell the Acura brand of cars, which will consist of only two models to start—the sports-oriented Integra hatchback and the luxury-oriented Legend V6. Both have been on sale in Japan since 1985, and both have Honda suspensions, 4-wheel disc brakes, fuel injection, front drive and a bit of excitement in the engine compartment.

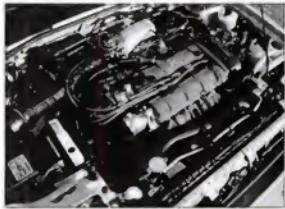
The Legend, base-priced at \$19,298 for the manual transmission (\$19,893 for the automatic), comes with a 151-hp, fuel-injected 2.5-liter V6 engine and offers enough standard features and luxury to make even Imelda Marcos feel at home. Your only choice is the transmission. There are no other options.

The V6 provides enough power to allow confident passing maneuvers and a top speed approaching 140 mph.

The 24-valve powerplant is a compact unit that fits in one of the best looking installations we've seen in a production car from Japan. We missed a dual-overhead-cam arrangement, but space considerations and a sloping hoodline



Single-overhead cam on the 151-hp Legend V6 engine allows for a low hood line.



Integra's 4-cylinder engine uses traditional dual camshafts to work its 16 valves.

did away with that possibility.

The sloping hood also demanded the use of a double-wishbone front suspension system similar to the new Accord's. Combined with an independent trailing arm system in the rear, the suspension transmits a minimum of noise and vibration to the passenger compartment.

That emphasis on passenger comfort does more to separate the Legend driver from the roadway than to enhance the driving experience. The result is a high-powered, lightweight sedan that never quite delivers in the handling department. Stuffing the Legend into a corner reveals the car's inherent understeer and an inability to react quickly to driver demands. The same system tends to cause an uncomfortable boating-like feeling on long, straight roads.

The Mercedes/BMW imitation interior pulls off the job pretty well. Gauges are large and easy to read. Blue-green lighting illuminates night work. We found some controls at the gimmicky end of the scale, though.

But where are the ABS brakes, heated seats and turbochargers? If Acura dealers are going to charge European prices, the Legend at least should be worthy of the hefty cost.

Integra cars deliver their goods in a well-designed package that ranges from \$9298 for the base 3-door RS hatch

(Please turn to page 124)

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SPECIFICATIONS

A plus 3000 is a complete, self-contained computer based on the popular 6502A microprocessor and can tap into the tremendous software library of Apple II. Features include 192K Bytes RAM, 32KB Enhanced Microsoft BASIC, 80 column text, 560H X 192V color graphic display, 81 key sculptured keyboard and high efficiency switching power supply. Also included as standard are Centronics bus printer interface, Cassette interface, 4 channel sound generator, and 5 1/4" Apple Compatible Disk Drive.

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- Character set with normal, inverse and flashing capabilities.

GRAPHICS

- 280H X 192V 6 colors — Black, White, Violet, Green, Blue, Orange.
- 280H X 192V 8 colors bit image — Black, White, Red, Green, Blue, Cyan, Magenta, Yellow.
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Features

	Aplus 3000	Apple IIe	Commodore C-128
RAM	192K	64K	128K
Runs Apple II Software	Yes	Yes	No
Function Keys	24	None	16
4 Voice, 6 Octave Sound	Yes	No	Yes
Composite Video	Yes	Yes	Yes
Disk Drive	Included	Extra Cost	Extra Cost
Numeric Keypad	Included	Extra Cost	Included
Video Cable	Included	Extra Cost	Extra Cost
RGB Color Card	Included	Extra Cost	Included
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Centronics Printer Interface	Included	Extra Cost	Extra Cost
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\$150 Wordprocessor (Magic Window)	Included	Extra Cost	Extra Cost
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Your Cost

\$399.00 \$1745.00 \$1117.90

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	LIST	SALE
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2 professional analog joysticks	\$ 39.95	\$ 24.95
2-80 card, allows CP/M use	\$ 99.95	\$ 59.95
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BUMPER CROP

(Continued from page 121)

with manual transmission up to \$11,833 for the 5-door LS automatic. Each Integra we drove carried the promise of high performance in a family-style car.

The 1.6-liter, dual-overhead-cam engine redlines at 7000 rpm, providing 113 hp at 6250 rpm. This 16-valve, 4-cylinder plant is already a proven commodity in Japan. Utilizing such technologies as hollow camshafts and an aluminum block, the engine weighs in at only 207 pounds.

Whether your Integra comes with the 5-speed stick or the 4-speed automatic with a lockup torque converter, you'll be able to appreciate the thrust of the little 1590-cc whiner.

With a somewhat dated Honda Civic suspension, the Integra has a nice stiff feel, and tracks like a slot car with a minimum of body roll in high-speed cornering. The Integra doesn't isolate you from the road.

As with all Honda products, both Acura models feature plenty of usable storage space and a fine attention to detail fit and finish. Both Legend and Integra are tautly constructed, with a minimum of noise and vibration entering the cockpit.—S.P.

Chrysler P-Cars

Chrysler jumps into the teeming sub-compact race with two more models for

(Please turn to page 126)

THE PM REPORT CARD

ACURA LEGEND	GRADE	COMMENTS
Acceleration	A-	V6 reminds us of European sports sedans
Handling	B	Acceptable for a luxury car, sloppy for sports-tourer
Braking	B+	Four-wheel discs, but no ABS
Steering	B-	Little road "feel"
Transmission	B+	Automatic jerky under hard acceleration; stick shift fine
Ride	A	Quietest, softest ride from Japan
Fuel economy	B+	19 city/25 highway estimates
Seating	B+	Five adults feel at home; driver's seat too stiff
Vision	A	Outside view has few obstructions
Gauges/controls	C	Gimmicky, complicated controls; gauges incomplete
Ventilation	A+	Meets all needs; easy to use
Noise @ 55 mph	A+	Exceptionally quiet at all speeds, can't hear engine at idle
Carrying capacity	A	Large trunk; plenty of interior nooks and crannies
Engine serviceability	A	All major components easily accessed
Fit and finish	B+	Up to Honda standards

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BUMPER CROP

(Continued from page 124)

1987, the Plymouth Sundance and the Dodge Shadow. The new cars, built in similar 2- and 4-door hatchback body styles, will compete in the market slot between the low priced Horizon/Omni and the mid-size Reliant/Omni.

With a drivetrain based on Chrysler's redoubtable K-cars, and a chassis much like the Laser/Daytona, the cars



Acura dealers will stock go-fast and look-fast parts from Honda specialist Mugen.

continue Chrysler's practice of using proven designs as building blocks for all-new models.

The engine and transmission are the front-drive package that Chrysler uses on its midsize models. A 2.2-liter, 135-cu.-in., 97-hp inline four is standard, while a 146-hp turbocharged version, which pounds out 50 percent more power, is the performance option.

(Please turn to page 128)

THE PM REPORT CARD

	ACURA INTEGRA GRADE	COMMENTS
Acceleration	A-	16-valve Four a spunky performer
Handling	B+	Surprisingly good for price bracket
Braking	A	Four-wheel discs on 2300-lb. car
Steering	B+	Good road feel; quick, accurate response
Transmission	B+	Stick a bit noisy
Ride	B	Too stiff for less "sporting" occupants
Fuel economy	B+	25.31 mpg reinforces "sport over economy" image
Seating	B-	Adequate for the price bracket
Vision	B+	Rearview mirror image small and distorted
Gauges/controls	B+	Gauges incomplete for sports use; controls clear and easy to use
Ventilation	B+	AC noisy and weak; air-flow good
Noise @ 55 mph	B	Sports-tuned exhaust a pleasant but constant companion
Cargo capacity	B+	Nominal for a hatchback
Engine serviceability	A	Easy access; plenty of room to work
Fit and finish	B	Typical for price range; we expected more from Honda

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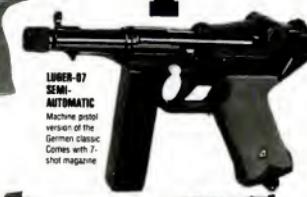
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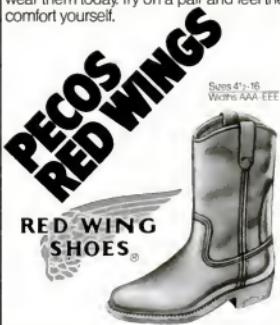
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- LUGER-47 SEMI-AUTOMATIC
- INGRAM M-11
SEMI-AUTOMATIC
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That's why working men who discovered Pecos boots two decades ago still wear them today. Try on a pair and feel the comfort yourself.



Sizes 4½-16
Wool's AAA-EEE

BUMPER CROP

(Continued from page 126)

Two proven transmissions are available, a 5-speed manual and a 3-speed automatic, both widely used on other corporation models.

What all this means to the P-car buyer is a new car that is built on major parts proven over many miles of customer use—an assurance that is the exception when other "completely new" models are introduced.—J.D.

Dodge Dakota

Dodge's new "mid-size" pickup falls somewhere between the compact



Dodge Dakota pickup has 112- to 124-in. wheelbase, 6½- or 8-ft. bed, V6 power.

Ranger and S-10 trucks and the full-size Ram 150. It's much bigger and roomier than the Japanese imports. Standard engine is a 93-hp, 2.2-liter Four that delivers 20 to 25 mpg with a 5-speed manual transmission. The optional 125-hp, 3.9-liter V6 is a pared-down version of Chrysler's proven 318-cu.-in. V8. With automatic transmission, the tor-

THE PM REPORT CARD

PLYMOUTH SUNDANCE	GRADE	COMMENTS
Acceleration	A/D	Turbo, one of the best in class; nonturbo lags severely
Handling	B	Quick; Chrysler has refined its front-drive chassis
Braking	C	Fair pedal feel, though somewhat soft
Steering	B	Faster steering, just like imports
Transmission	B	Typical Chrysler fast shifts
Ride	C	Better than Horizon/Omni, leans toward firm
Fuel economy	B	Small engine, light chassis gives good mpg
Seating	C	Best feature is upright position
Vision	B	High seat is a good vantage point
Gauges/controls	C	Tilted instrument panel looks uneven
Ventilation	B	No one does this better than U.S. makers
Noise @ 55 mph	D	High road rumble; little wind noise
Cargo capacity	B	Lots of room
Engine serviceability	C	Typical front-drive space squeeze
Fit and finish	B	Prototypes approaching Japanese standards

quey V6's 195 lb.-ft. will haul payloads up to 2250 pounds or trailers up to 5500 pounds. It will also do 0 to 60 in under 15 seconds.

A brake proportioning valve helps to fight an empty pickup's tendency to lock up the rear brakes and skid during a panic stop. The valve adjusts pressure to the rear brakes according to the

THE PM REPORT CARD

DOODGE DAKOTA GRADE	COMMENTS	
Acceleration	A	Best you can get without a massive V8
Handling	B	A cinch to drive in tight spaces
Braking	D	Rear wheels want to lock up on slick pavement
Steering	B	Precise; good balance between road feel and ease of turning the wheel
Transmission	A	Well matched to engine and vehicle; needs overdrive
Ride	B	Long wheelbase helps; unloaded ride a bit firm
Fuel economy	C	A step or two above the big pickups
Seating	B	Good room for two; three adults a squeeze
Vision	A	Excellent view to side, rear and forward over low, short hood
Gauges/controls	B	Some gauges hidden by wheel rim
Ventilation	B	Car-like vents work well
Noise @ 55 mph	B	Rivals many sedans in noise control
Cargo capacity	A	Pick the long box for all you want to carry
Engine serviceability	C	High fenders impede getting both hands on engine
Fit and finish	B	Excellent on this prototype hand-prepped by pros



Chrysler P-cars are solid, tight and quick, but transmit lots of road noise to the driver.

weight over the rear axle. Proportioning valve or not, I was still able to lock up the rear brakes on a gravel road and nearly spin out.

Look for Dodge and other pickup manufacturers to introduce full-fledged ABS brake systems during the next two years.—J.D.

Dodge Shelby GLH-S

Chrysler sure knows how to spin a lot of variety out of every model it owns, and the Dodge Omni is a prime example, running from the \$5500 Omni America stripper to the \$8816 GLH Turbo hot

rod. Carroll Shelby has raised the performance ante another notch with his new GLH-S model, which adds an intercooler, almost 30 horses, and \$1500 to the recipe. The result is a 175-hp stormer that Shelby claims can beat a stock Porsche 944 or Ferrari 308! Other additions include Koni adjustable struts, 205/50-15 VR-rated Goodyear Eagle gatorback radials, neat 15 x 6-in. aluminum wheels, driving lights, halogen headlights, air dam and side spats. A blackout grille treatment and tinted glass add to the sinister look. Inside, there's a "Rally" instrument package and leather-wrapped steering wheel and shift knob. There's a lot of perfor-



Carroll Shelby strikes again with this 175-hp intercooled version of the Omni.

mance for the buck here, if you can overlook a lot of humble econocar origins that can't be hidden by the glitz and go.—S.P.

London Taxi

Appropriately enough, it was a rainy, foggy morning when I went out to LondonCoach Inc. in Mount Clemens, Michigan, to drive the latest version of

THE PM REPORT CARD

LONDON TAXI	GRADE	COMMENTS
Acceleration	C	4-cylinder power in heavy 3200-lb. car
Handling	A	Excellent at moderate to low speed
Braking	B	Four big drum brakes tend to squeak
Steering	A	Precise, good feel; built for tight maneuvers in city traffic
Transmission	C	3-speed Ford automatic does the job, no more
Ride	B	Excellent on smooth roads; throws passengers about on rough surfaces
Fuel economy	C	Moderate to poor; 20/23 mpg
Seating	A+	Chair high, firm rear seat, deeply padded
Vision	A+	Lots of flat glass plus high perch
Gauges/controls	C	All there, but housed in unimaginative panels
Ventilation	B	A/C standard, sliding windows drop all the way down
Noise @ 55 mph	B	No luxury sedan, but a relief after the roar during acceleration
Cargo capacity	A	Tiny trunk, but front passenger seat can be used
Engine serviceability	A	Hood and grille swing way up, exposing engine
Fit and finish	C	Built for long service, not looks

the original London Taxi, now 27 years old. Tall as the average man, at 69½ in., but no longer than a compact car (185 in.), these nimble mini-limousines can make a U-turn in an incredible 25 ft. Other handy features for taxi use include bolt-on fenders and door panels, extra heavy-duty suspension, seats for three to six passengers (three are folding jump seats) and odd counterbalanced door glass that slides up and down like a sash window! In London,



London Taxi aims to replace the Checker as the only cab designed for the job.

these iron cabs run 10 years and 750,000 miles (with engine changes) compared to the 24 to 36 months and 300,000 miles for a \$10,000 to \$11,000 U.S. cab. LondonCoach hopes that will justify the \$18,500 price tag.

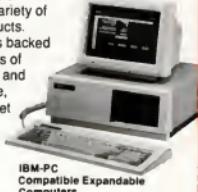
In the U.S., London Taxis come with 2.3-liter Ford 4-cylinder engines and automatic transmissions.—J.D.

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Jeep Comanche 4wd with 2.8-liter V6 is set up for work and comfort; sticker is \$15,900.

JEEP COMANCHE XLS

Off-road limo

COLT VISTA 4WD

Family funhouse

BUICK RIVIERA T TYPE

Blinded by science

This month we've gained a truck (Jeep's compact Comanche pickup), lost a van (the Chevy Astro), gained a luxury coupe (the Buick Riviera), lost a performance coupe (the Merkur XR4Ti), and soldiered right along with

the Colt Vista 4-wheel-drive wagon.

Jeep Comanche

It would be a tough customer who didn't take a shine to the new Jeep Comanche. After all, our 4wd longbox pickup, based on the much-loved and well-proven Cherokee/Wagoneer series, carries a name synonymous with durability and go-anywhere tenacity. Our first go-around with the Comanche came at the chassis-busting *Torture Test* (page 84, Sept. '85), where it survived intact and was ranked in the middle of the field.

Out in the real world of everyday

commuting and weekend cargo hauling, the Comanche proves to be as comfortable as it is durable. It should be, too. Loaded up with \$6859 worth of options, the total price skyrockets from a base of \$9050 to \$15,900 for our full-boast XLS backroad limo. That doesn't include the tachometer or towing package we ordered but didn't receive. The trailer hauling gear was retrofitted by the local dealer since we already had the prerequisite suspension and cooling system options in place.

AMC made a number of wise choices in building this series—biasing the ride quality toward over-the-road comfort,



Colt Vista 4wd, a favorite of PM staff, has logged 5000 trouble-free miles so far.



Plush, all-electronic Buick Riviera T Type had a few gremlins in the high-tech works.

offering a range of plush interior options and, most of all, using proven components from outside suppliers. Our Jeep is powered by the Chevrolet 2.8-liter V6, a longtime friend that we find trustworthy but a little lacking in power on a cold morning driveaway. AMC's own Four is a thoroughly modern engine that may serve just as ably where heavy payload is not an issue.

A supportive set of seats go a long way to making the Comanche a pleasure to spend time in. But there are a few detracting touches to the interior—chintzy chrome switchgear that's entirely out of place and an annoying resonance that surfaces when idling in traffic, probably from the cab's plastic sliding rear window. *We do like*, however, the extra capacity gas tank (23.5 gallons vs. 16), which gives us a 225-mile range between fillups at our average 14.1 mpg reading.

A pickup always seems to find a multitude of uses, whether you live in the country or the city, and we'd say that the Comanche doesn't make you suffer during those times you're using it as regular transportation. With the snowy 4-wheel-drive season over in these parts, we'll soon report on its towing mettle as the boat-and-trailer season approaches.—N.S.M.

Colt Vista 4wd

This one's a real crowd-pleaser. The kids, especially, love it. The Vista, built by Mitsubishi for Dodge and Plymouth dealers, looks like a tiny van, but is actually a front-drive station wagon built on a modified Colt chassis. The 4-wheel drive is engaged simply by pushing a button on the shift lever. It's not for off-roading, but for the times when you need extra traction in snow, sleet or rain.

Leaving one toll booth on my commute is always an adventure because the pavement has been polished smooth by millions of jackrabbit starts. In slippery weather, rear-drive cars slew sideways without warning, front-drive cars just sort of stand still and gravitate slowly to the right, wheels spinning. But the Vista 4wd motors merrily away from the pack. Of course, this is about the only time you'll out-drag anyone in the 88-hp Vista. Its dry-pavement performance is strictly in the appliance category. But that's okay. You don't buy a Vista to race Porsches.

We do have a few minor gripes about the Vista. Most serious is the feeble ventilation system, which can't defog the windows when three or more people are in the wagon. Most annoying is the \$195 AM/FM radio. Its range is short and FM stations constantly drift out of tune, especially when you hit a bump. My 13-year-old (who knows about such things) points out that, for less money,

you can get a 4-speaker boom box with AM/FM/short wave, graphic equalizers and dual cassette decks. We've come to expect more quality and value from Japanese electronics than we find in this Mitsubishi radio.

Another problem is the central locking system, which locks all four doors at the turn of a key, but not the cargo hatch, which must be locked separately. Since there's no visual indication of whether the hatch is locked or not, it's easy to forget. An oversight in this department allowed our \$240 radar detector to be ripped off from the parking lot of the local racquet club.

Otherwise, the Vista's given us 5000 trouble-free miles, averaging about 18 mpg in city driving and 25 mpg on the highway. We've just discovered a crimp in the exhaust pipe, probably caused by backing into a high curb. When that's straightened out, our fuel economy should improve.—W.H.

Buick Riviera

The Riviera T Type is doing a short stint in our test fleet before moving on to Project Car duty. It's received mixed reviews, especially the CRT dash display. Our Auto Editor (who is beginning to show his age) really liked the CRT, and the whole rest of the Riv, pointing out that it is probably the best of the new downsized GM luxury cars—Cadillac Eldorado and Seville, Olds Toronado, and Riviera. Other drivers were less enthused.

For all the convenience we are supposed to be afforded by the Riviera's advanced touch-screen control center, it still violates the First Commandment of ergonomics—you must take your eyes off the road to make any adjustments. Without any tactile reference points, you can't simply slide your fingers up to the radio, count three push-buttons over from the left and tune in the 24-hour news station. In fact, try it and you may well fire up the defroster or call up the average sailcats per mile for your last excursion to Budapest.

If that wasn't trouble enough, you often have to shuffle through two or three screen menus to reach the control you want. And though many settings are remembered for short intervals when the car is shut off, an overnight stop puts everything back to baseline.

The first sign of malfunction in the system was a radio that refused to shut off, which also kept the power antenna from retracting. Then a hiccup in the oil pressure sending unit kept triggering a LOW OIL PRESSURE warning. When the warning comes up it preempts all other screen displays, so you can't adjust anything else. Compounding the confusion was the fact that this leading-edge technology car doesn't carry an oil pres-

(Please turn to page 132)

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LONG-TERM CAR TESTS

(Continued from page 131)

sure readout in its gauge mode (just a tachometer and voltmeter), so we were no better off than the poor guy who has only an idiot light. Surely with all that electronic capacity, this vital gauge could have been included in the T Type.—N.S.M.

Merkur XR4Ti

After its initial teething troubles (see *PM Long-Term Car Tests*, page 88, April '86), our Merkur delivered another 6000 miles of relatively trouble-free, sensual pleasure, delivering 26 mpg and consuming its usual quart of oil every 1200 miles.

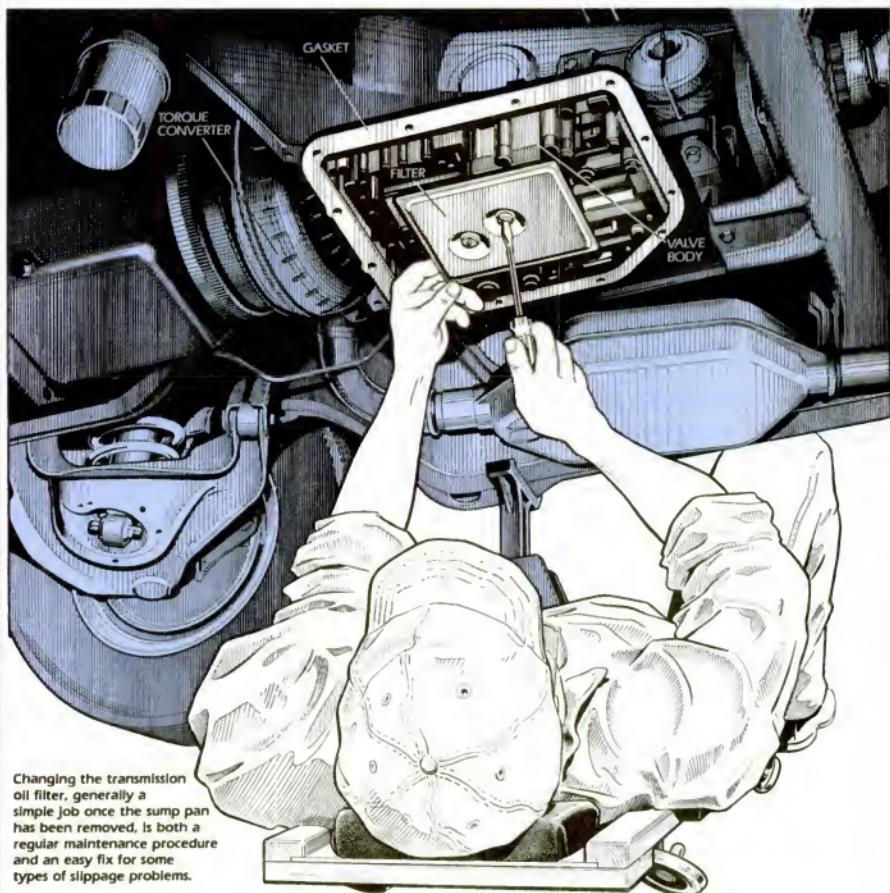
At 13,500 miles, a heater hose clamp vibrated loose, spilling coolant all over the place. And by 14,000 miles we noted that the 1-2 synchro was getting kind of balky and easy to beat on fast shifts. Despite these glitches, this German hot rod remained the most popular car in our fleet. So popular, in fact, that when it was left overnight on a street in Connecticut, some felon broke the passenger window and removed the radio from the dash, apparently using a chain saw. The damage was so extensive that we had to go back on our promise never to give the car back to Ford. This was a shame, as we felt the car was just hitting its stride.—W.H.

Chevrolet Astro

After several pointed reminders from Chevy's long-suffering PR man, we returned a somewhat battered Astro van with 11,864 miles on the clock. It had had a few scrapes with New York City traffic and our parking garage. Three Firestone Supreme tires had been blown out on potholes (a record, even for us). Also, the number of minor failures was approaching the terminal stage. The fuel gauge had become permanently stuck on FULL, causing us to estimate fillups by the odometer. The speedo was fine, but all the minor instruments were performing erratically. The seatbelt was unreeled all by itself. Four quarts of coolant had escaped to somewhere. And the rattles were multiplying like wire coat hangers in a dark closet. We'd averaged 12.9 mpg in the kind of short-haul and commuting use to which vans are put.

Although we were impressed by the Astro's cargo-hauling ability, its general comfort level left a lot to be desired, and its reliability gave new meaning to the Chevy advertising claim that "no one sweats the details like Chevrolet." We sweated them, too! If our Astro was a typical example, GM has a long way to go to catch up with general American automotive quality levels, much less Japanese.—W.H.

SATURDAY MECHANIC

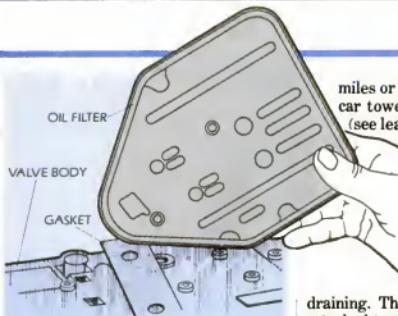


Changing the transmission oil filter, generally a simple job once the sump pan has been removed, is both a regular maintenance procedure and an easy fix for some types of slippage problems.

AUTOMATIC TRANSMISSION IN-CAR TUNEUP

BY PAUL STENQUIST

Automatic transmission—the words alone are enough to bring a chill to the heart of most Saturday mechanics. Those complex conglomerations of valves, clutches, bands, planetary gears, bushings, shafts, springs and spacers are strictly a don't-touch item for most of us. There is almost nothing that can ruin one's day more quickly than an apparent transmission failure. In some cases the failure will be accompanied by a strong



1 Oil filter assembly can be detached from valve body by removing two screws.

odor of rotten eggs and burnt transmission fluid. If that happens, you can be sure that internal damage has already occurred, and a major rebuild or a replacement are the only solutions.

But some transmission problems do not immediately lead to internal damage. And in many cases, the box can be repaired easily without removing it from the car. In the following sections we'll explain in-the-car fixes for several common causes of trans problems.

Low oil level or clogged filter screen

If the trans fluid level drops below the pickup, the internal clutch mechanism won't apply when you shift to DRIVE. The same thing will happen if the fluid pickup screen becomes clogged. If you rev the engine to make the car move, you could burn the clutches or bands. That's why it's important to keep an eye on fluid level, correct any leaks immediately, and change fluid and filter at appropriate intervals.

Fluid and filter change intervals vary widely depending on use. GM's latest recommendations call for changes every 15,000 miles if the vehicle is used in heavy city traffic where outside temperature regularly reaches 90°, if the vehicle is used in a hilly or mountainous area, if it's used to pull a trailer, or if it's used for commercial service. For other uses, the recommendation is 100,000 miles.

In actual practice, most cars don't fit neatly into one category or the other. The 100,000-mile figure applies to a car that is only used for long trips in nice weather on flat terrain—hardly the case for most of us.

If you're faced with a transmission that doesn't respond when you shift to DRIVE and you haven't changed the filter and fluid within the last 50,000

miles or so, do it before having the car towed to a transmission shop (see lead illustration). Since most transmissions don't have a drain plug, you'll have to lower a corner of the pan to drain the oil, leaving two bolts in place in the opposite corner. Remove them gradually as the fluid stops draining. The filter is within the pan, attached to the valve body (Fig. 1).

If leakage causes fluid level to drop a few quarts or more below normal, fix the leak and top off the fluid level before you condemn the trans. In some cases it won't be damaged. Of course if you drive a great distance with the trans slipping, you'll burn it up.

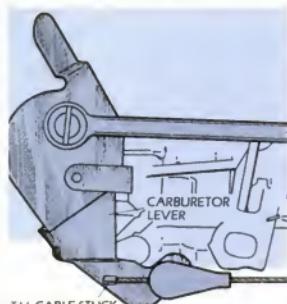
Repairing fluid leaks

Some causes of fluid loss, including front pump seals, require transmission removal and disassembly. Others, including rear seal, pan gasket, case porosity, or trans cooler line leakage can frequently be fixed in the car.

Leaks are sometimes hard to localize because the air that passes under the car while you're driving tends to spread the fluid over a wide area.

Leaking rear seals are a common cause of fluid loss on rear-wheel-drive cars. Fluid coats the underside of the car behind the transmission, but the trans itself will usually be dry. If the trans is filled with fluid to the recommended level, you might be able to spot it dripping from the area where the driveshaft slips into the transmission tailshaft housing.

In most cases this seal can be re-

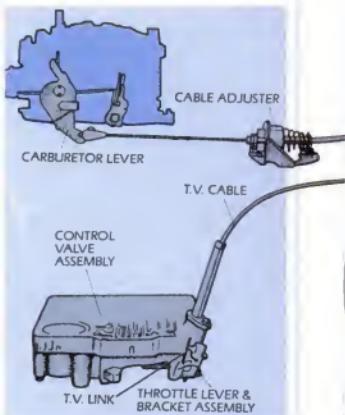


2 When pulled out and released, the T.V. cable should return to its original position.

placed without removing the trans from the car. Using a boxwrench, unbolt the driveshaft from the third member. Push the shaft forward to disengage it from the rear end's pinion flange. Then, with a drain pan positioned under the trans rear seal area, pull the driveshaft slip joint out of the transmission.

Inspect the driveshaft slip joint surface. If it's grooved from friction with the trans oil seal, it must be replaced.

If the slip joint is okay, replacing the seal should stop the leak. Use a screwdriver or hook-tool to pry the seal from the housing if you can do so without damaging the housing. Some automakers and aftermarket tool companies sell



3 Pressing a tab on cable adjuster of some GM models will adjust the T.V. cable.

a special tool for this job.

Cut the outer casing of the new lip seal with a nonhardening gasket adhesive or RTV and drive it into the housing with a large socket or piece of pipe that fits closely on the rim of the seal. If you can't find a suitable driver, you may want to purchase the tool that the automaker uses. Once the seal has been replaced, reinstall the driveshaft and top off the fluid level.

The lines that join the automatic transmission to the cooler in the radiator are a common source of fluid leakage. This type of leak can be detected by fluid wetness near the lines. On rear-drive cars this is generally the right side of the trans. These steel lines will sometimes wear through in spots where they come in contact with cross-

members or frame parts. When the engine is running, you should be able to see fluid drip from the damaged line.

The best fix is to replace the lines with new ones from the dealer. In most cases these come pre-bent with the appropriate fittings on each end.

However, on older cars you might not be able to free the fittings from the radiator or transmission. In these cases, you can splice a section of heavy-duty neoprene hose into the line. Hose is available in two sizes, $\frac{3}{8}$ -in. and $\frac{5}{16}$ -in. i.d. Check the outside diameter of your trans cooler line. Use a hose that fits snugly over the steel line.

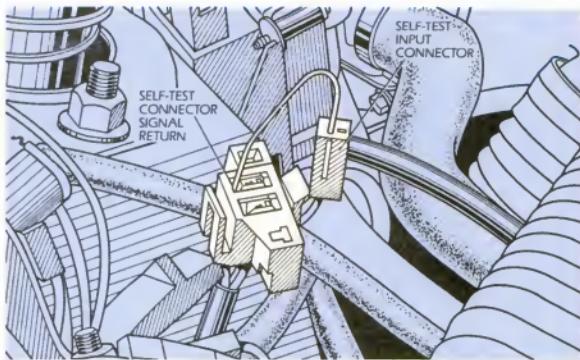
Remove a section of the leaking line, 6 or 7 in. on each side of the leak. Use a tubing cutter or a hacksaw. Place a drain pan under the line before you cut. Install the hose using four screw-type clamps.

The hose must fit snugly. If it slides right over the tube, it's too big. Make sure at least 6 in. of hose is fitted over the tube. Top off the fluid. Then run the engine, watch for leaks and recheck clamp tightness. Be sure to correct the chafing condition that caused the original leak.

A bad pan gasket is easy to replace once it's been diagnosed, but don't use RTV or gasket cement as it might clog the trans' valve body.

Misadjusted linkage

Do the markings on your trans position indicator correspond to the transmis-



5 Connectors that are jumped to retract Ford ISC plunger are at right fenderwell.

sion's actual operation? The manual linkage must be adjusted so that the engine will start in the PARK and NEUTRAL positions only, and the pointer on the indicator quadrant should line up in each range. If the linkage is maladjusted, an internal fluid pressure leak can occur at the shifter valve. This causes slippage and clutch and band failure. If misadjustment is extreme, the car may not move at all in DRIVE.

To adjust the linkage on most cars, just place the selector lever in PARK, disconnect the linkage from the trans, locate the trans shift lever in PARK and then shorten or lengthen the linkage until it fits on the trans shift rod. On cable linkages, the cable adjuster is used to change the linkage length. On rod linkages there is usually a rod that screws in or out of its rod end or a stud and nut that slide in a slot. Some linkages, including Fords, are adjusted in the DRIVE position. If a visual check doesn't reveal the adjustment mechanism, consult a shop manual.

Damaged T.V. cable

The throttle valve cable joins your trans to the carburetor or fuel-injection throttle body. This linkage moves a valve in the trans that regulates fluid pressure according to throttle opening.

You'll find this mechanism on many automatic transmission cars. Some Fords have a rod linkage.

A sticking or binding T.V. cable can cause delayed or full-throttle-only upshifts. To check the cable on late-model GM cars, run the engine at idle with the trans selector in NEUTRAL and the parking brake applied. Pull the engine end of the cable through the cable

terminal and then release it (Fig. 2). It should return to the closed throttle position against the cable terminal.

If the cable sticks and doesn't return to the cable terminals, check for a sharp bend in the cable, a damaged cable housing, a burr on the T.V. link, a bent T.V. link, misalignment of the throttle lever and bracket assembly, a damaged or binding throttle lever and bracket assembly, or an unhooked throttle lever spring. By examining the cable and observing the cable and linkage in action, you can usually spot the problem area. Correct by replacing the cable, by removing burrs with a file or sandpaper, by straightening sharp bends or by eliminating alignment problems.

GM T.V. cable

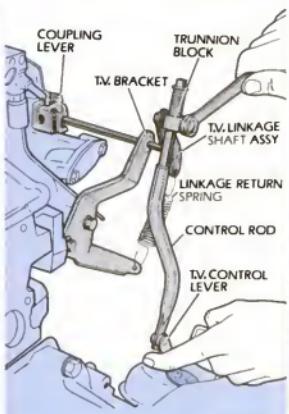
If the cable is misadjusted, it can cause delayed, early or slipping shifts, and prevent manual downshifts.

To adjust the cable on a gas-engine GM car with rear-wheel drive, turn off the engine. Then depress the readjust tab at the cable adjuster assembly and move the slider back through the fitting, away from the throttle body, until it stops against the fitting. Release the readjust tab, open the carb lever to the full throttle position and release (Fig. 3). This will automatically adjust the cable.

Check for sticking or binding as described above. Then road-test the vehicle to make sure the problem is fixed.

Ford T.V. cable

To adjust a T.V. cable on a front-wheel-drive Ford with any engine except the 2.3-liter CFI, run the car until the engine reaches normal operating tem-



4 Front-drive Ford T.V. linkage is adjusted after loosening trunnion block bolt.

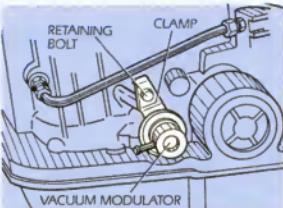
perature. Turn off all accessories and check idle speed to make sure it conforms to the spec on the underhood Vehicle Emission Control Information label. The throttle lever must be off of the choke fast-idle cam.

Loosen the bolt on the sliding trunnion block on the T.V. control rod assembly (Fig. 4) at least one turn. Remove any corrosion from the control rod so that the trunnion block slides freely on the rod. Then, with the engine idling and the trans selector in PARK, rotate the transaxle T.V. control lever up using one finger. This should position the T.V. control lever against its internal idle stop. Without relaxing the force on the control lever, tighten the bolt on the trunnion block to between 7 and 11 ft.-lb.

On front-wheel-drive Fords with the 2.3-liter CFI, warm the engine as above, then hold the throttle open to maintain 1000 rpm while pressing lightly on the idle speed control (ISC) motor shaft. After the shaft retracts completely, release the throttle and quickly unplug the ISC motor connector. Adjust the linkage as above, then reconnect the ISC motor.

To adjust the cable on a rear-drive Ford with the AOD transmission and no ISC, adjust curb idle to spec, position the trans selector in NEUTRAL, apply the parking brake and unscrew the linkage lever adjusting screw until the end of the screw is flush with the face of the lever. Then turn the screw in until a .005-in. feeler gauge fits snugly between the end of the screw and the throttle lever. Before checking clearance, push the linkage lever forward and release it. Do not apply any load on the levers while checking the gap. Once the gap is correct, turn the adjusting screw an additional three turns. If you can't turn it three turns, one turn will do. If you can't get at least one turn, you'll have to adjust the linkage at the transmission. See your shop manual.

If your AOD-equipped Ford has an ISC motor, locate the Self Test Connector and Self Test Input Connector in the engine compartment. On most cars they're in the area of the passenger-side fender well. Connect a jumper wire between the STI connector and the Signal Return Ground on the Self Test Connector (Fig. 5). Turn the ignition key to the run position without starting the engine. This will cause the ISC plunger to retract. Turn off the key and remove the jumper wire and the air cleaner. Then adjust the T.V. linkage as described above.



6 Vacuum modulator is located on the transmission case, above the pan flange.

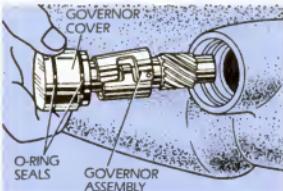
Chrysler T.V. cable

To adjust the T.V. cable on a front-wheel-drive Chrysler, warm the engine until it is off fast idle, then loosen the adjustment bracket lock screw. The bracket should slide in its slot. If it won't, disassemble and clean or repair both the bracket and the case boss sliding surfaces.

Slide the bracket toward the engine as far as it will go. Release the bracket and move the throttle lever fully to the right against its stop. Then tighten the adjusting bracket lock screw to 9 ft.-lb. Test cable operation by moving the transaxle throttle lever forward and then slowly releasing it. It should return fully rearward.

Chrysler Torqueflite transmissions use a rod linkage to control the throttle valve. To adjust, warm the engine until the carb is off the fast-idle cam, then set the idle speed according to directions on the Vehicle Emission Control Information sticker. Make sure the linkage is free to move. If not, clean and repair it.

Once you're sure engine temperature and idle speed are okay and the linkage is free to move, raise the car to gain access to the trans throttle lever, taking all normal safety precautions. Then loosen the adjustment swivel lock screw. The swivel must be free to slide along the flat end of the throttle rod. Hold the trans lever firmly forward against its internal stop and tighten the



7 Shift-control governor can often be removed with transmission still in the car.

swivel lock screw to 8 ft.-lb. Lubricate the upper and lower bellcrank pivot areas with a thin coating of multipurpose grease.

Test to make sure the linkage moves freely by moving the throttle rod rearward and slowly releasing it. It should return fully forward.

Vacuum modulator failure

Some cars, particularly older ones, are equipped with a vacuum modulator that controls shift points and harshness. The device, a diaphragm controlled by engine vacuum, moves a valve in the transmission. It can be found on the outside of the transmission case and looks like the diaphragm that controls advance on a distributor (Fig. 6). It's joined to the intake manifold or carb base by a vacuum tube. Vehicles equipped with this include all pre-1981 Fords, late-model rear-drive Fords with C-3 or C-5 (no overdrive) transmissions, Chevettes, GM A-cars with 4-speed transaxles, and most pre-1983 GM cars.

Symptoms of modulator failure include harsh and delayed upshifts or no upshifts. A soft and early upshift from SECOND to THIRD can also be a modulator problem. Sometimes, when the modulator diaphragm tears, fluid is drawn into the engine, causing exhaust smoke and low fluid level. An engine vacuum leak can make the car perform as though the modulator is bad.

If you replace a modulator, make sure the O-ring is in place on the new unit.

Other do-it-yourself fixes

There are a few other trans components that can be serviced in the car. While space does not allow complete coverage of repair procedures here, these jobs are detailed in both manufacturer's and general service manuals.

On many transmissions, the governor, a device that controls shifts in regard to engine speed, can be removed and replaced without trans disassembly (Fig. 7). A bad governor will usually cause the trans to remain in FIRST. If the governor seals leak, shift points may be higher than normal.

Dirt in the valve body—a network of valves and passages that control trans operation—can cause a wide variety of shift problems. Although valve body failures are not very common, they can occur. On most cars, the valve body can be removed from underneath once the shift mechanism, oil pan and filter have been removed.

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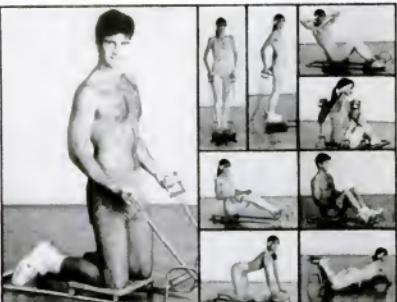
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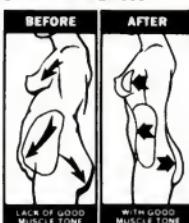
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Push-Pull Tapper gives 7:1 gear reduction and is reversible.

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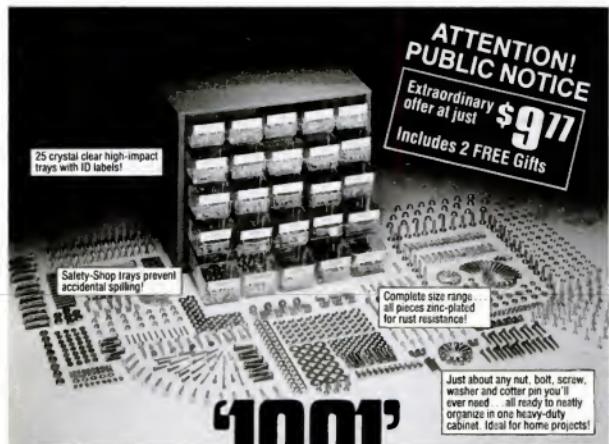
The Pneumatic Liquid Evaporator eliminates moisture in a compressed air supply before it reaches the spray gun. The evaporator (No. BT-8100) and filters can be ordered from Burroughs Tool & Equipment Corp., 2429 North Burdick St., Kalamazoo, MI 49007, for \$41.



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WINEMAKERS—Beermakers: Free illustrated catalog of supplies. Semplex, Box 12276R, Minneapolis, Minnesota 55412-0276

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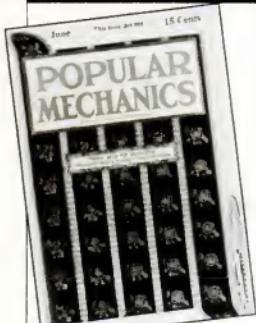
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TIME MACHINE

75 YEARS AGO: June 1911



Color for motion pictures.

Silver screen color

"Kinemacolor," a new motion picture color process, brought the bright colors of a budding rose to the movie screen. The system used a whirling tricolored filter disc mounted in front of the lens of a movie camera loaded with black-and-white film. A similar disc in front of the projector lens provided images which copied natural colors "to a remarkable degree of perfection." Though Kinemacolor never did catch on, the same idea resurfaced 40 years later in early attempts at color TV.



Grandstand construction sets record

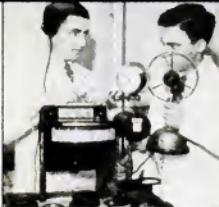
A fire that destroyed a major-league baseball park grandstand in Washington, D.C., only 25 days before opening day set the stage for a dramatic demonstration of new construction tech-

niques. It took 800 men only 22 days (and nights) to create a concrete grandstand 500 feet long and 69 feet wide. Construction involved pouring at a record rate of 1 square yard per minute.

50 YEARS AGO: June 1936

All for a picture

Aerial cameramen gave those trusty biplanes a workout in their never-ending quest for unusual and exciting shots. PM's cover showed a stunt-pilot's eye view of the world at the beginning of a loop. Other photographs showed the ground as seen by an upside-down flier and by one in the middle of an inside loop. The planes themselves were the subjects of other photos, including those showing the frame-and-fabric craft in the process of diving, looping and stalling out.



Telephone 'wires'

The "latest turn of radiotelephony" was the transmission of dot-dash code between a plane and the ground over an infrared beam. The man sending the message faced a microphone and "talked" in "dit-dah" code, imitating telegraph dots and dashes. At the receiving end, the message was heard as a shrill interrupted whistle. Light beams offered high security for communications between aircraft or naval vessels. The 10-pound system could even be adapted for use in spy balloons.

Art of aerial photography.

25 YEARS AGO: June 1961

Backyard eagles

Some wild and wonderful homebuilt planes were taking to Oregon's skies. Sparked by Silas Christoferson and John Burkhardt, Oregon's pioneer plane builders, the Oregon chapter of the Experimental Aircraft Assn. was the nation's most active group. Their creations included a 1937 flying saucer (that one didn't fly), a 4-engined executive amphibian, a biplane-to-monoplane conversion and a "double cub" (these all flew). Many members built their own autogyros.



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Man-made Island

A 385-acre man-made island, to be completed at the same time as the new Oakland Bay Bridge, was built as the site of the San Francisco International Fair.



Amphicar

A spiritual descendant of the WWII Army Duck, the Amphicar was either a seagoing sports car or a highway-happy motorboat. The 43-hp Triumph engine in this little rear-engined package drove the two rear wheels when it was on land, or its rear-mounted twin props when it was in the water. The Amphicar was less than completely successful as either a boat or a sporty car, but was nevertheless a very clever design, and was in any case a whale of a lot of fun—on land or lake.

Component bow

Fiberglass bows, though a boon to archers, have posed problems in matching bows to individual archer's needs. A mix-and-match box, with a variety of interchangeable parts, provided a wide range of sizes, stiffnesses and grip patterns for almost any enthusiast.



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you hoping for more. A look that's straight, direct, unshakable. The name is Dodge.

[†]Shown with dealer installed options.

^{*}Limited warranty on the engine, powertrain and against outer body rust-through. Excludes leases. Restrictions apply. See copy at dealer.

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